

Daily report

13-05-2020

Analysis and prediction of COVID-19 for EU-EFTA-UK and other countries

Foreword

The present report aims to provide a comprehensive picture of the **pandemic situation of COVID-19** in the EU countries, and to be able to foresee the situation in the next coming days.

We employ an **empirical model**, verified with the evolution of the number of confirmed cases in previous countries where the epidemic is close to conclude, including all provinces of China. The model does not pretend to interpret the causes of the evolution of the cases but to permit the **evaluation of the quality of control measures made in each state** and a **short-term prediction of trends**. Note, however, that the effects of the measures' control that start on a given day are not observed until approximately 7-10 days later.

The model and predictions are based on two parameters that are daily fitted to available data:

- ✓ α : the velocity at which spreading specific rate slows down; the higher the value, the better the control.
- ✓ K : the final number of expected cumulated cases, which cannot be evaluated at the initial stages because growth is still exponential.

We show an individual report with 8 graphs and a table with the **short-term predictions** for different countries and regions. We are adjusting the model to **countries and regions** with at least 4 days with more than 100 confirmed cases and a current load over 200 cases. The **predicted period** of a country depends on the number of datapoints over this 100 cases threshold, and is of 5 days for those that have reported more than 100 cumulated cases for 10 consecutive days or more. For short-term predictions, we assign higher weight to last 3 points in the fittings, so that changes are rapidly captured by the model. The whole methodology employed in the inform is explained in the last pages of this document.

In addition to the individual reports, the reader will find an initial dashboard with a brief analysis of the situation in EU-EFTA-UK countries, some summary figures and tables as well as **long-term predictions** for some of them, when possible. These long-term predictions are evaluated without different weights to datapoints. We also discuss a specific issue every day.

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(0) Executive summary – Dashboard

Global EU+EFTA+UK trends and needs

EU+EFTA+UK has recovered the trend after a few days of some inconsistencies or surprises in data.

New cases return to the level of <10,000 after a peak that was higher than expected.

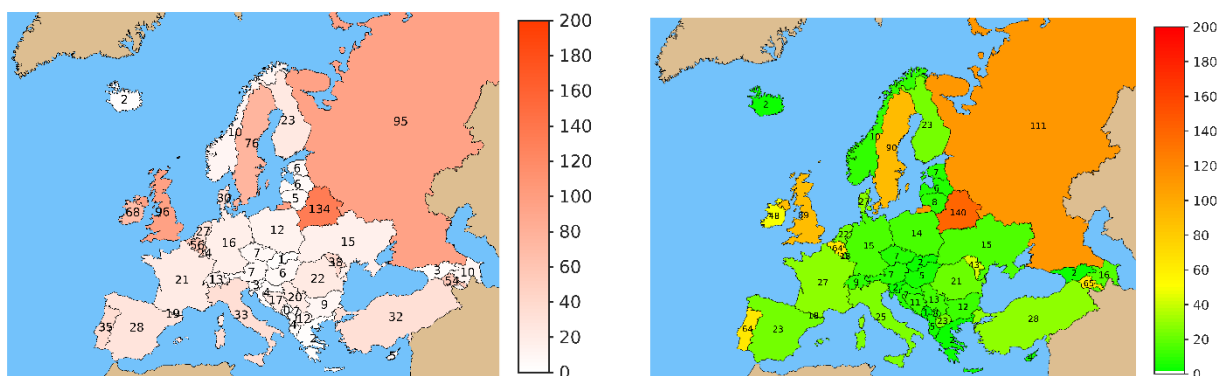
In the last few days, ρ_7 was increasing. Luckily, it now seems to be recovering the trend to decrease as well. Thus, both the new daily cases and the ρ_7 are indicating a good trend. We must keep in mind when we consider all countries that changes are slow. Therefore, although we are improving, we must be patient to consolidate such improvement.

In the last section **we analyse the risk red zone in the risk diagrams**, as well as its meaning and implications from the control perspective.

Trends for specific countries

United Kingdom could overcome **Spain** in absolute number of cases tomorrow, according to predictions. In the table of the next page, **Spain** is already in second position because we are waiting for the regularization of 2,715 cases that have to be located correctly in the timeseries. Meanwhile, these cases have been released from the historical series so that trends and indexes can be correctly evaluated. **France** ρ_7 is still affected by a similar problem last week. **Portugal** remains at a high ρ_7 , but observing the trend in new cases it seems a problem in data reporting as well.

The map in the left shows current **A₁₄**. The map in the right shows current **EPG**.



Situation and trends per country

Table of current situation in EU countries. Colour scale is relative except when indicated, this means that it is applied independently to each column, and distinguishes best (green) from worst (red) situations according to each of the variables. Last column (EPG_{EST}) indicates EPG assessed with **estimated real 14-day attack rate** (see report from 22/04 for details). EPG_{REP} is calculated with **data reported by countries**. EPG_{REP} and EPG_{EST} **cannot be compared between them** because scales are different, but can be independently used for estimating risk of countries according to reported or estimated real situation, respectively.

Country	Reported data						Indexes		
	Cumulative cases	Attack rate /10 ⁵ inh.	Cumulative deaths	Mortality /10 ⁵ inh.	Active cases (last 14 days)	14-day attack rate /10 ⁵ inh.	$\rho_7^{(1)}$	$EPG_{REP}^{(2)}$	$EPG_{EST}^{(3)}$
Spain	227.660	491,2	26.744	57,7	16.732	36,1	1,14	41	493
United Kingdom	223.060	335,7	32.065	48,3	65.911	99,2	0,95	94	1.439
Italy	219.814	369,9	30.739	51,7	20.400	34,3	0,73	25	351
Germany	170.508	208,2	7.533	9,2	14.171	17,3	0,94	16	75
France	139.519	215,6	26.643	41,2	13.749	21,2	1,38	29	582
Belgium	53.449	470,6	8.707	76,7	6.762	59,5	1,09	65	1.095
Netherlands	42.788	251,9	5.456	32,1	4.543	26,7	0,84	22	296
Switzerland	30.261	353,1	1.542	18,0	1.180	13,8	0,61	8	44
Portugal	27.679	266,9	1.144	11,0	3.535	34,1	1,84	63	283
Sweden	26.670	271,1	3.256	33,1	7.744	78,7	1,16	92	1.254
Ireland	23.135	489,5	1.467	31,0	3.487	73,8	0,73	54	358
Poland	16.326	42,7	811	2,1	4.424	11,6	1,09	13	75
Austria	15.874	182,2	620	7,1	618	7,1	1,02	7	28
Romania	15.588	78,8	972	4,9	4.249	21,5	1,04	22	162
Denmark	10.513	184,1	533	9,3	1.815	31,8	0,92	29	153
Czech Republic	8.176	77,1	282	2,7	727	6,9	1,02	7	25
Norway	8.106	151,0	224	4,2	573	10,7	1,03	11	31
Finland	5.984	108,7	271	4,9	1.289	23,4	1,06	25	131
Luxembourg	3.888	675,0	101	17,5	159	27,6	0,72	20	48
Hungary	3.313	34,0	425	4,4	664	6,8	0,70	5	66
Greece	2.726	24,4	151	1,4	192	1,7	1,04	2	11
Croatia	2.196	52,1	91	2,2	157	3,7	1,76	7	NA
Bulgaria	1.990	27,9	93	1,3	627	8,8	1,34	12	NA
Iceland	1.801	494,4	10	2,7	9	2,5	0,74	2	NA
Estonia	1.741	132,7	61	4,6	94	7,2	1,07	8	NA
Lithuania	1.485	51,1	50	1,7	36	1,2	1,04	1	NA
Slovenia	1.460	70,3	102	4,9	53	2,6	0,75	2	14
Slovakia	1.457	26,8	26	0,5	76	1,4	1,49	2	NA
Latvia	946	48,0	18	0,9	128	6,5	0,94	6	NA
Cyprus	901	77,0	22	1,9	79	6,8	0,63	4	NA
Malta	503	117,2	5	1,2	53	12,4	NA	NA	NA
Liechtenstein	83	215,3	1	2,6	0	0,0	NA	NA	NA

Scale									
Worst	Worst	Worst	Worst	Worst	Worst	Worst	2,0	200	2000
Best	Best	Best	Best	Best	Best	Best	0,0	0	0

⁽¹⁾ ρ_3 is the average of 7 consecutive ρ , but can still fluctuate. ⁽²⁾ EPG stands for Effective Growth Potential. EPG_{REP} is obtained by multiplying attack rate of last 14 days per 10⁵ inhabitants (i.e. density of cases) by ρ_7 (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days). EPG_{EST} is obtained by multiplying estimated real attack rate of last 14 days per 10⁵ inhabitants by ρ_7 .

Highlights for countries with highest number of reported cases

- ✓ Spain is still revising the historical series of Catalunya to locate the dates of 2,715 cases. Meanwhile, we have removed those cases from the historical series so that trends can be correctly analysed.
- ✓ UK shows a new decrease in new cases that could lead the country to the level of 3,000 daily cases the next days.
- ✓ The five countries with highest number of reported cases have a ρ_7 close to 1, Italy being the one with the lowest value (0.7).

Time indicators by country

This table summarizes a few time indicators for each country: time since 50 cases were reported, time interval between an attack rate of $1/10^5$ inhabitants and an attack rate of $10/10^5$ inhabitants, and time interval between attack rates of 10 to 100 per 10^5 inhabitants (only for countries that have overtaken this threshold).

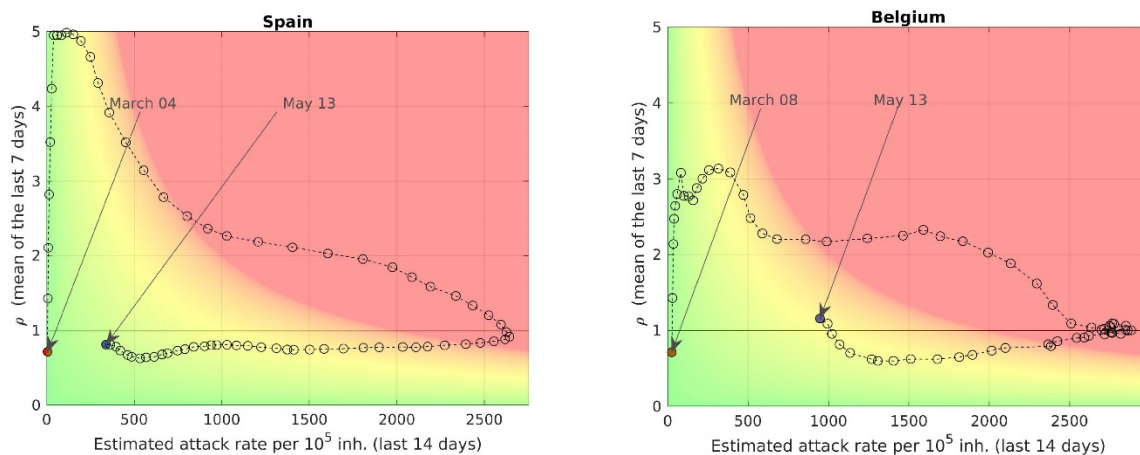
Countries	Days since the first 100 cases	Time interval between 1 and 10 cases / 10^5 inh. (days)	Time interval between 10 and 100 cases / 10^5 inh. (days)
Italy	80	11	16
Germany	74	12	17
France	73	10	20
Spain	72	8	12
Belgium	68	11	14
Netherlands	68	11	20
Sweden	68	10	28
Norway	68	9	24
Switzerland	68	9	12
Austria	66	10	14
Denmark	65	4	30
Czech Republic	62	11	NA
Finland	62	12	46
Greece	62	18	NA
Iceland	62	5	15
Portugal	61	9	15
Slovenia	61	6	NA
Estonia	60	5	30
Ireland	60	8	18
Poland	60	17	NA
Romania	60	15	NA
Luxembourg	57	6	7
Slovakia	56	24	NA
Bulgaria	55	30	NA
Croatia	55	12	NA
Hungary	54	20	NA
Latvia	54	12	NA
Lithuania	53	9	NA
Malta	52	9	35
Cyprus	51	12	NA

Analysis: The red zone for contact tracing.

We have recently used Risk diagrams to describe the evolution of the situation in different countries. As explained before, the X-axis shows the 14-day attack rate, A_{14} . In the Y-axis we plot the average level of epidemic growth during the last week, which gives an indication of number of contacts and the possibility of having similar infection chains in the recent future.

If we want to use these diagrams to work on a deconfinement process, it can be of interest to focus on the estimated number of real cases rather than reported. The reason is that one of the requirements for a secure process is related with the country's capacity to detect infected people and carry out contact tracing. Therefore, **in this analysis we will use the estimated risk diagram (i.e., plotted using estimated A_{14}) and the EPG_{EST} .**

As important as having a fast way to assess the evolution of the epidemics in any particular region, the key visual information comes from the colour behind each point. Red indicates large attack and growth rate. We show here the **estimated risk diagrams** of the countries that went deeper to the red-color areas during the epidemic, according to estimated incidence:



As it can be seen in the graphs above, we are using a level of 2,000 estimated people per 100,000 that can infect other as our red zone. **The reason behind red colour is related with the ability to control the possible contagion chains.** More specifically, **we define the red zone as that situation where we consider that, in the short-term, is impossible to do contact tracing and have a control of the epidemics by detecting and isolating new cases.** Therefore, the above countries can only control the epidemics by enforcing physical distance and a reducing across the board the total number of contacts.

The goal of controlling the epidemics via contact tracing needs the implementation of three crucial infrastructure:

- First, the ability to test with PCR at large enough numbers.
- Second, the ability to contact and take samples of all close contacts of any positive case.
- Third, the ability to track that people indeed follow the quarantine imposed in case they are positive.

When a country has restrictive measures of contacts, the ability of contact the closest relatives is relatively easy. There is no need for a large-scale research of work and friend contacts during the last days. Similarly, if public gatherings are forbidden and public transport access is regulated in terms of social distance, no super spreader is to be expected. In this stage, the most important roadblock to contact tracing is the ability to take samples and do PCR tests at the proper scale.

We have already introduced the key figure is how many PCR tests per day per 100,000 people can a city, country or region perform. We will call this index DTL for Daily Testing Level. We show here this number for some key countries¹.

Country	Population (millions)	Maximum daily tests	DTL (rounded)
USA	328	320,000	100
Italy	60	60,000	100
Spain	47	4,000	85
France	67	24,000	35
Germany	83	67,000	80
UK	66.5	65,000	100
Denmark	6	15,000	250
South Korea	51.5	15,000	30
Israel	9	15,000	165

It is clear from the table that **DTL=50 is key**. This same number is, roughly, the level of testing that South Korea had set up from the very beginning of the epidemics in the country (DTL=20-40). As we have discussed previously it is clear that with the appropriate low level of cases DTL=50 is the level where the epidemic can be controlled. Precisely, South Korea had a reported attack rate below 15 at the most and they controlled it while having DTL=20 at the very beginning. But **the level of testing in the table also indicates that it is impossible to trace any country with estimated A_{14} larger than 2,000 given that, at most, DTL=50-100.**

Taking into account that the symptoms take around 4-6 days to develop, it means that 2,000 cases per 100,000 inh. require to test 500 people per 100,000 per day in order to clean the backlog of people who actively can transmit the disease. With present level of testing this is not possible. However, one could think that you could stretch your capabilities entering the typical time frame and that you can use a full 20 days to detect people, being 20 days the typical time scale between symptom and death. Germany is taking roughly one week to detect. Other typical delays are around 12 days. **So, in the red zone, even with the higher DTL**

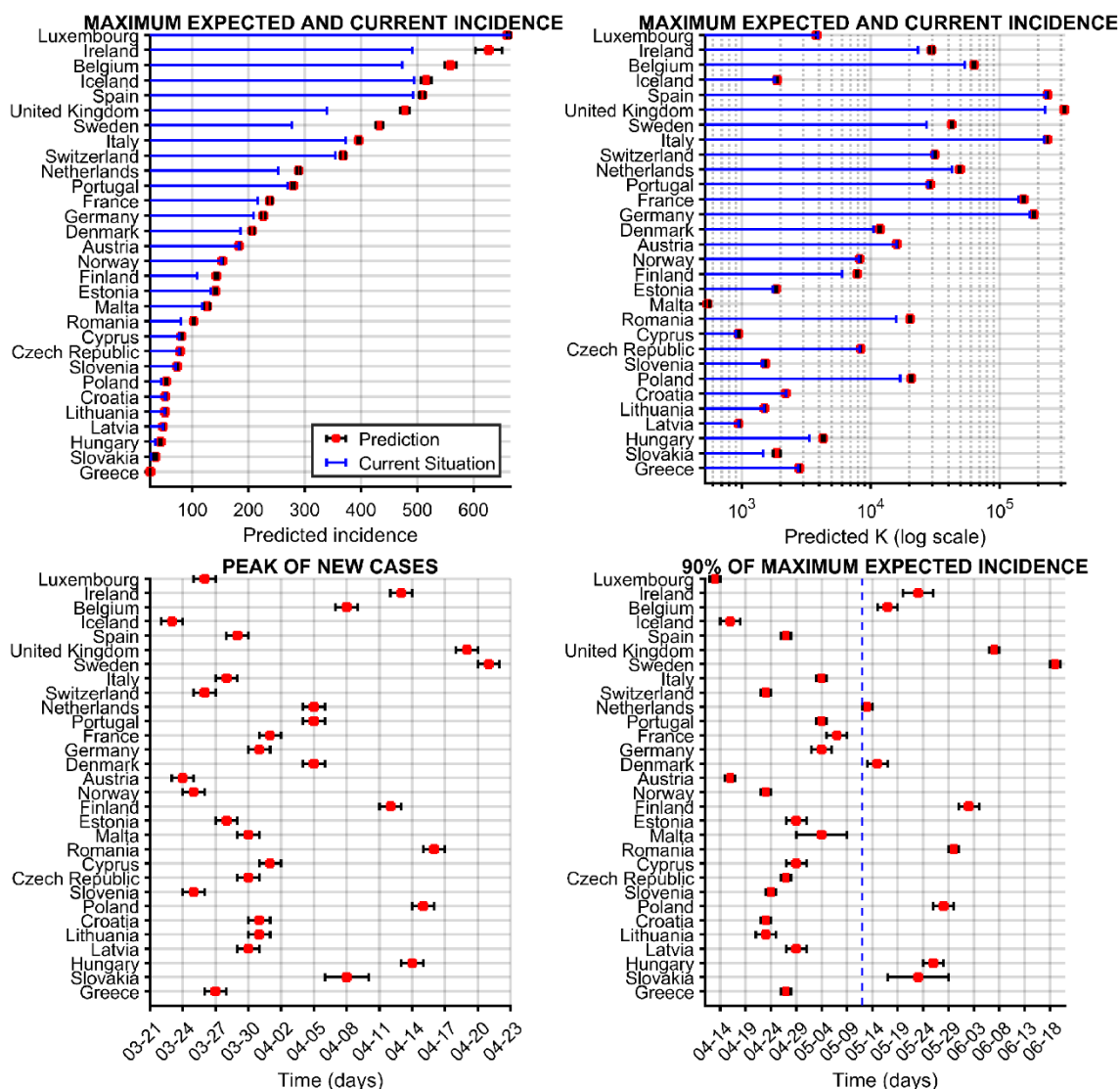
¹ USA: FiveThirtyEight.com @NateSilver and <https://ourworldindata.org/grapher/full-list-daily-covid-19-tests-per-thousand>
Italy: <https://www.rtve.es/noticias/20200418/cuantos-test-coronavirus-hacen-otros-paises-comparacion-espana/2012292.shtml>
and <https://ourworldindata.org/coronavirus-testing>
Spain: https://www.elconfidencial.com/tecnologia/ciencia/2020-04-21/datos-test-pcr-covid-19-verdades-mentiras_2557907/
Germany: https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Situationsberichte/2020-04-29-en.pdf?__blob=publicationFile
UK: <https://ourworldindata.org/grapher/daily-covid-19-tests-rolling-3-day-average>
France: Indirectly from https://en.wikipedia.org/wiki/COVID-19_testing and news reports about not reaching targets.
Denmark: <https://www.statista.com/statistics/1106073/tested-and-confirmed-coronavirus-cases-in-denmark/>
South Korea: <https://ourworldindata.org/grapher/full-list-daily-covid-19-tests-per-thousand>
Israel: <https://www.timesofisrael.com/israel-sees-sharp-increase-in-coronavirus-testing-inks-deal-with-chinese-firm/> confirmed:
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available nowadays (100) and with the longest time delay to detection possible (20 days from symptom to death), contact tracing cannot work.

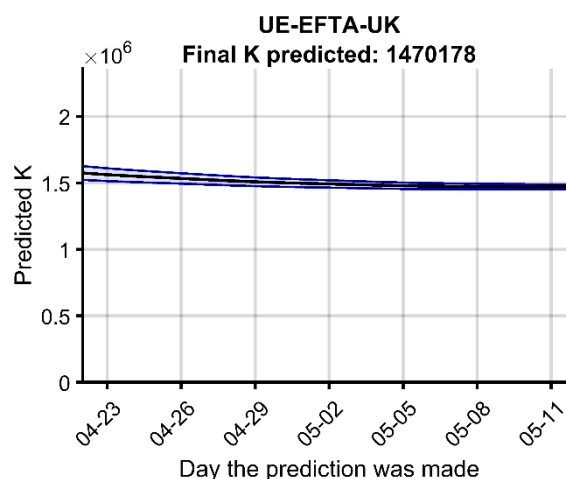
We must insist that being out of the red zone does not mean having the ability to do contact tracing. As we have explained before, you would need to have the proper structure of testing and to detect new cases, ideally, just when infected develop symptoms. Not only samples have to be taken and processed, positive cases must be followed and guarantee its isolation. An extra layer of difficulty will appear when countries start to let people meet in bars and the possibility of having unknown contacts comes into place. At this point, tracing the people who you need to test becomes the key roadblock.

Long-term predictions

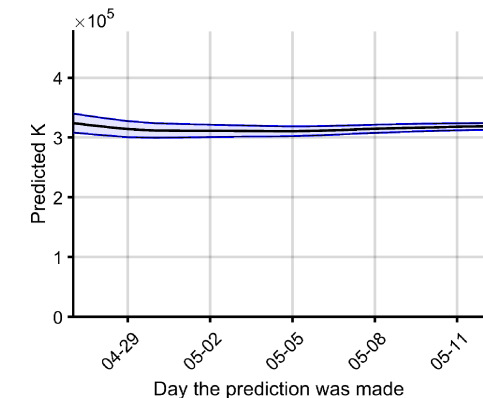
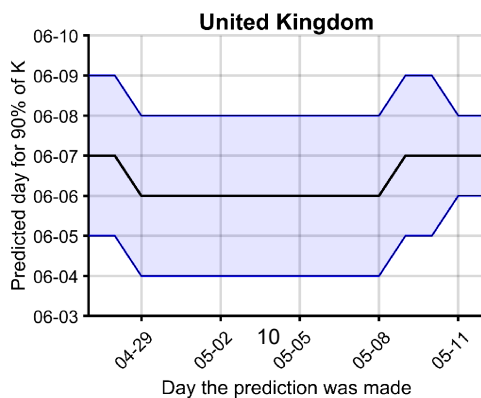
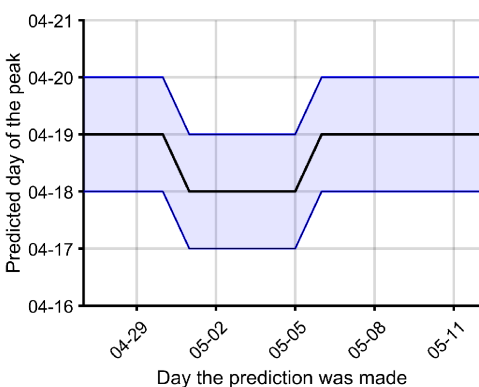
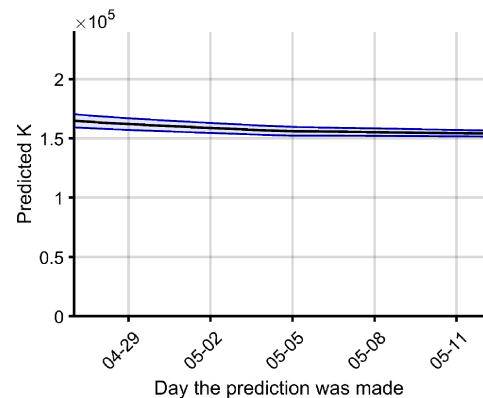
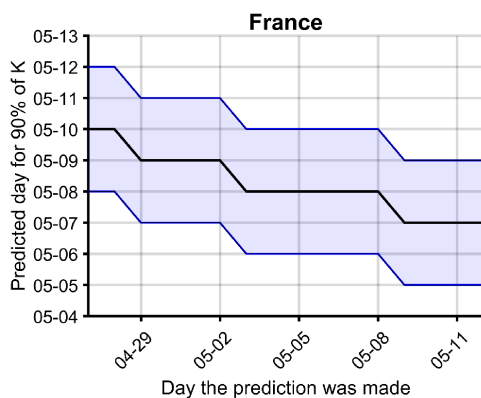
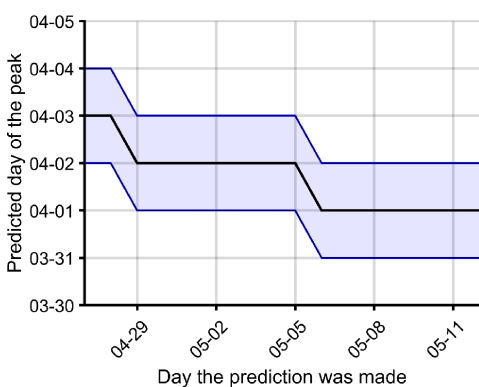
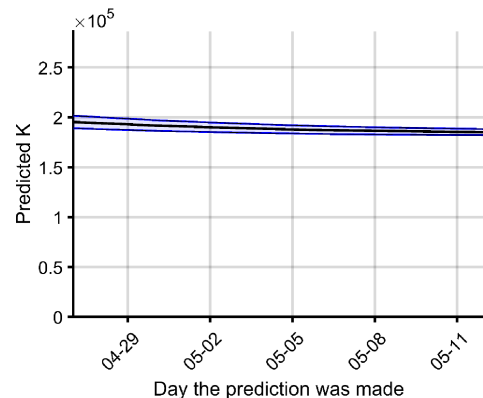
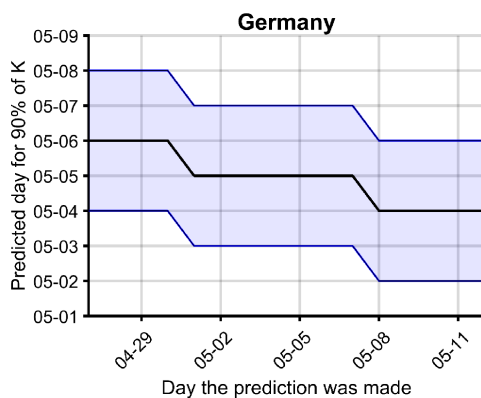
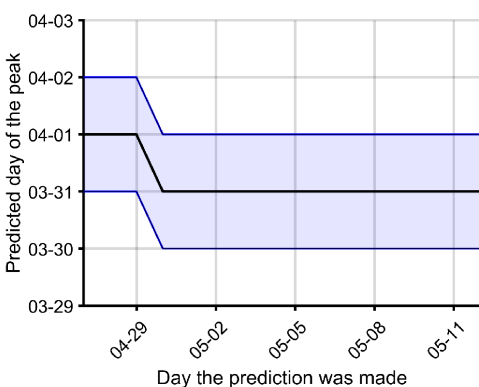
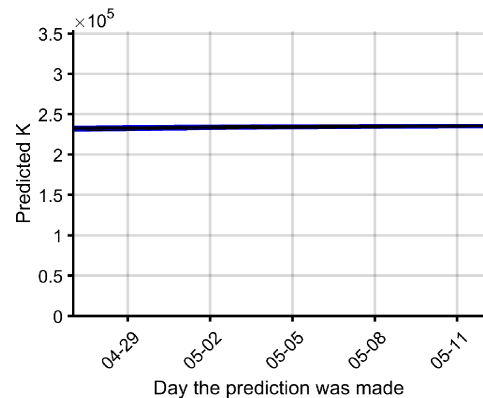
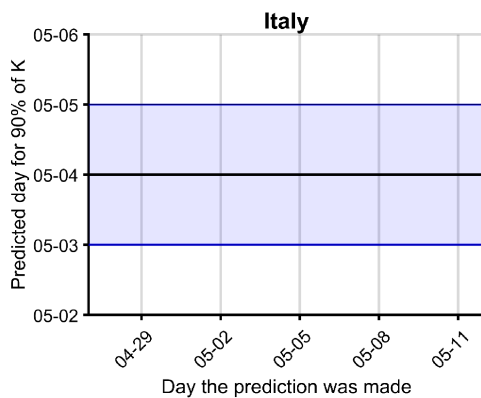
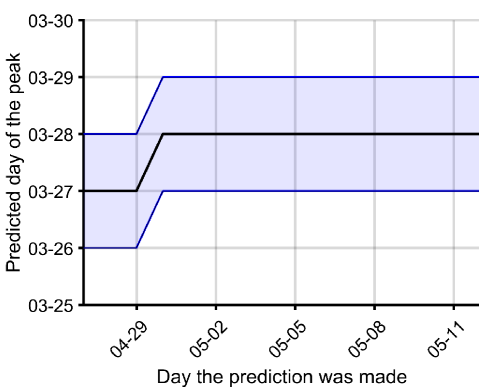
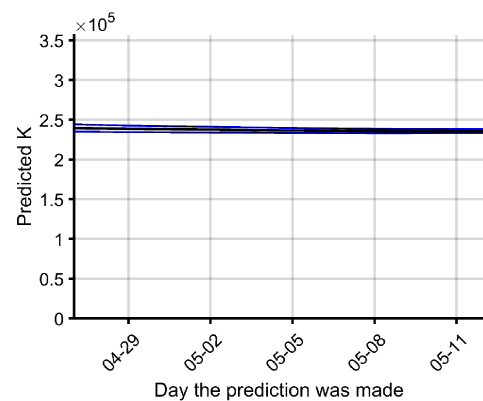
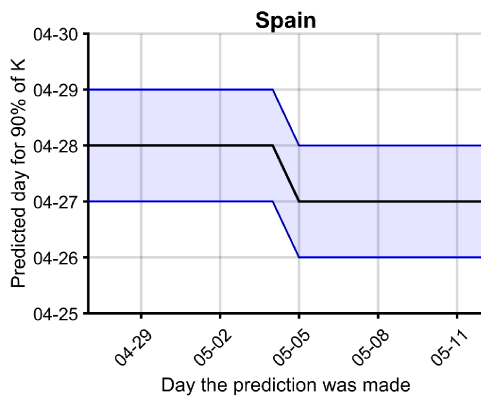
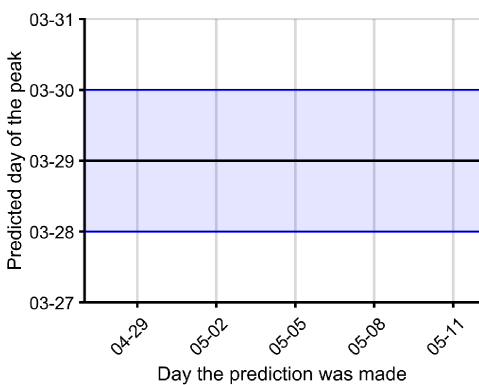
Long-term predictions, evaluated with the **whole historical series** and without weighting last 3 points. Up-left: Predictions of maximum incidences per country (total final expected attack rate per 10^5 inh.). Up-right: Predictions of maximum absolute number of cases per country (K, in log scale). Blue lines indicate current situation. Bottom-left: Time in which peak in new cases was achieved / will be achieved. Bottom-right: Time at which 90 % of K was achieved / will be achieved. Blue dotted line indicates current date.



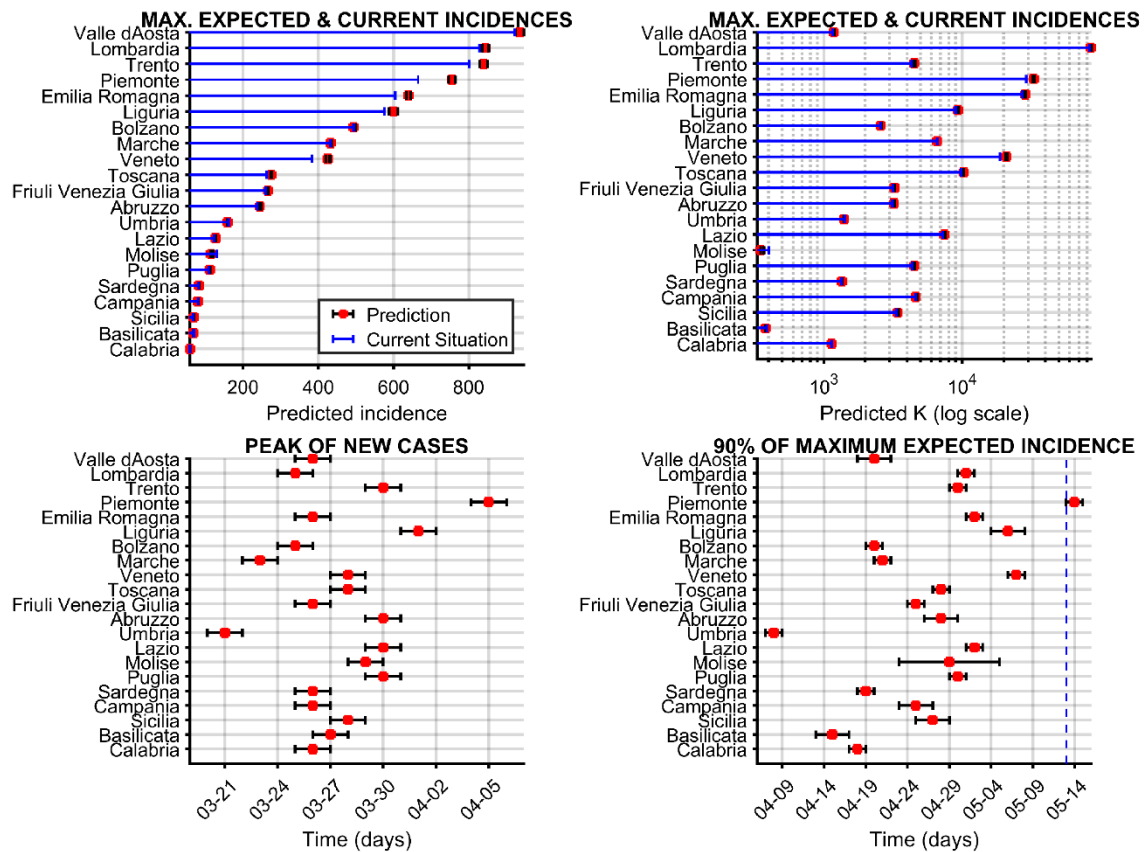
Final expected K for UE+EFTA+UK. Evolution of predicted K with time, where convergence to best estimate is seen. Last prediction is numerically shown in title.



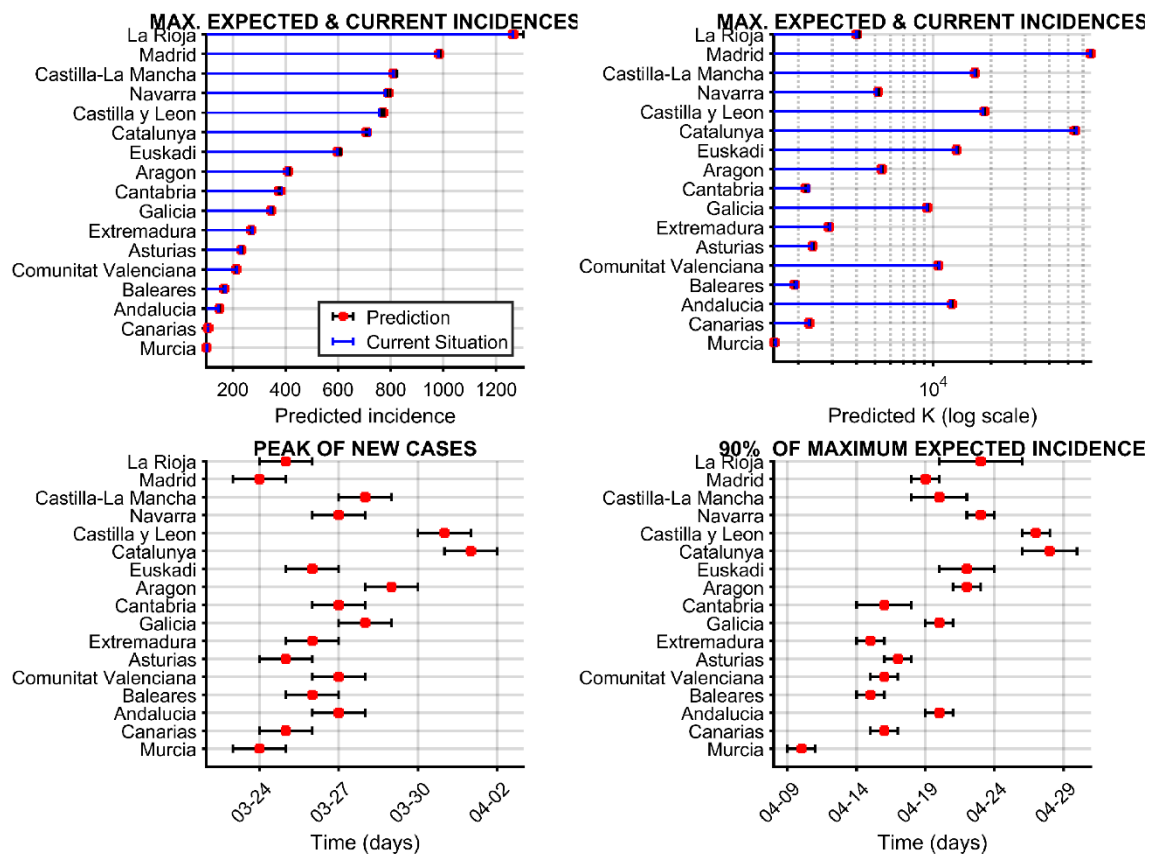
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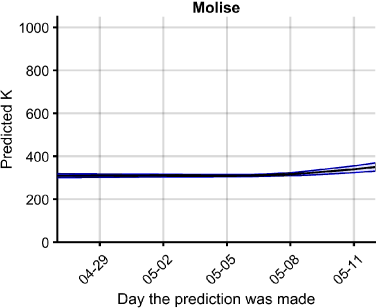
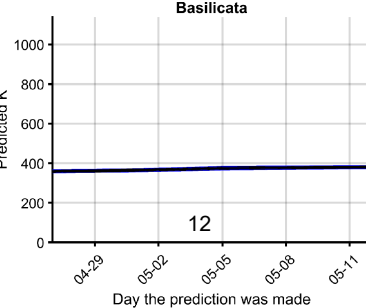
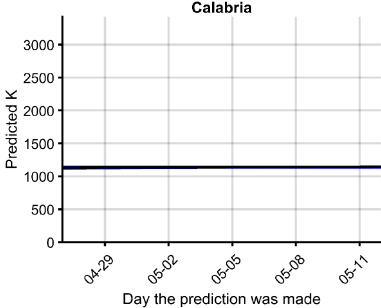
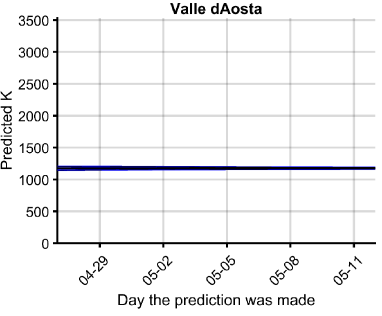
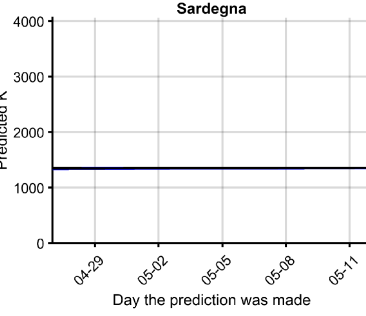
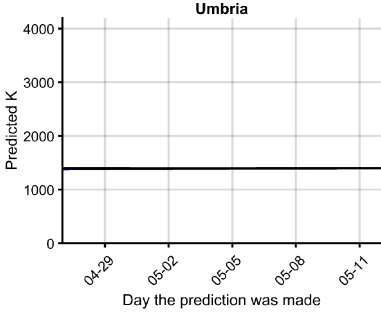
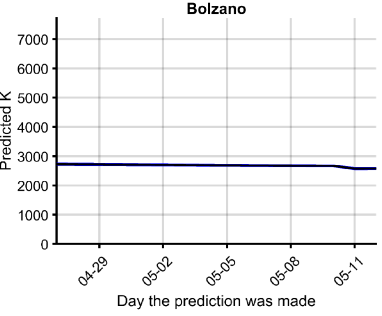
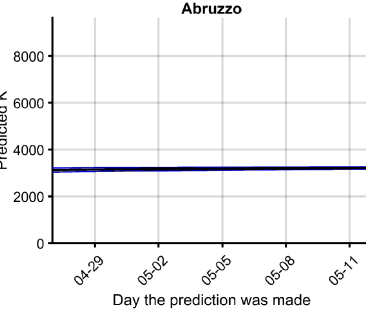
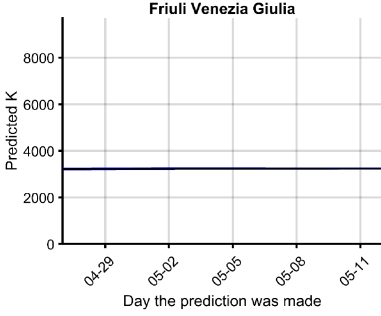
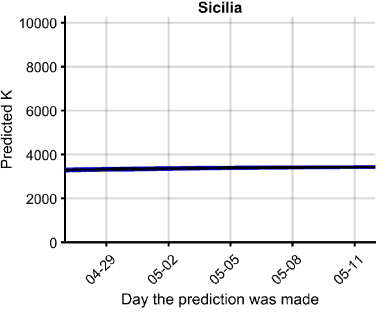
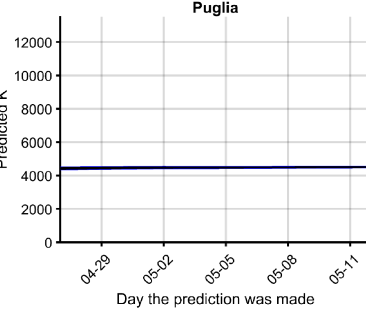
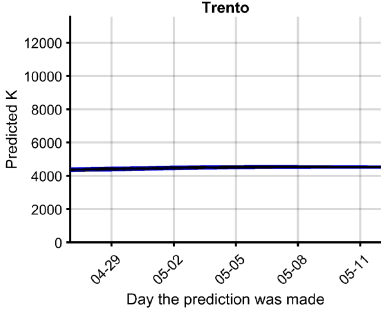
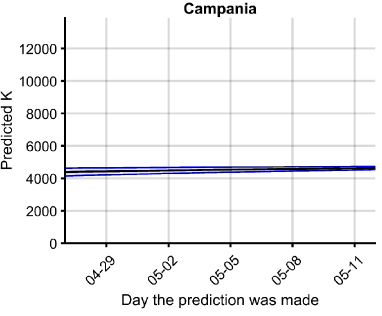
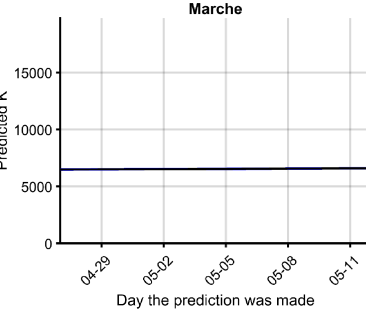
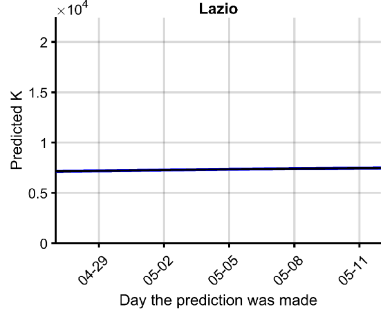
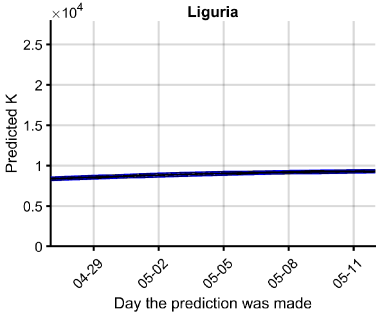
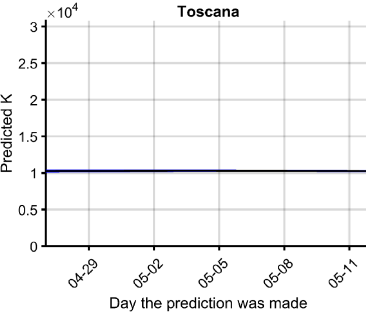
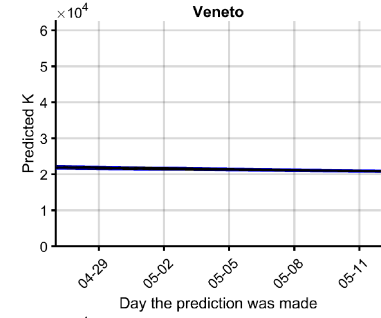
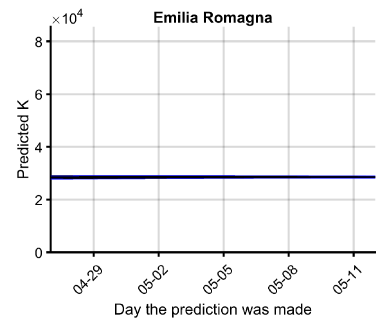
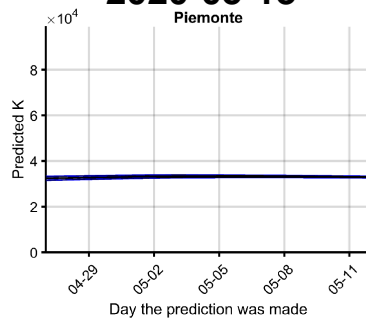
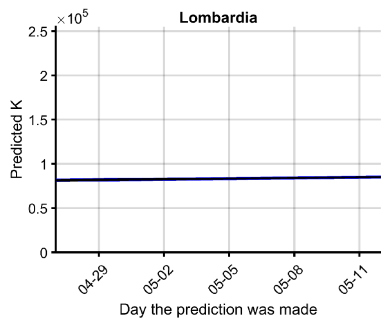
Italian regions



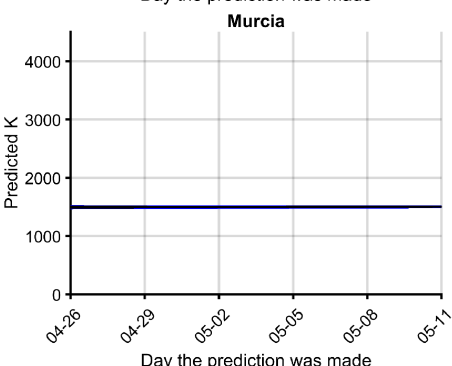
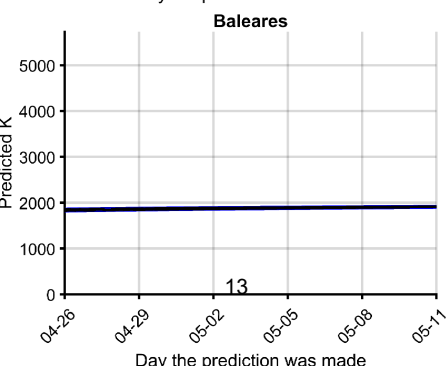
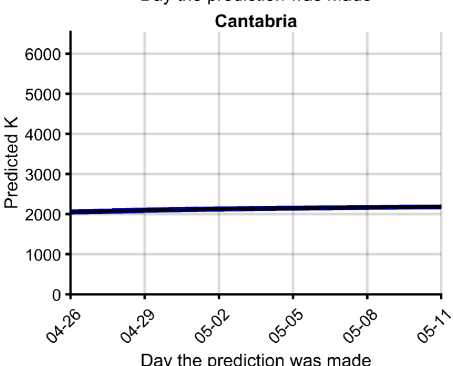
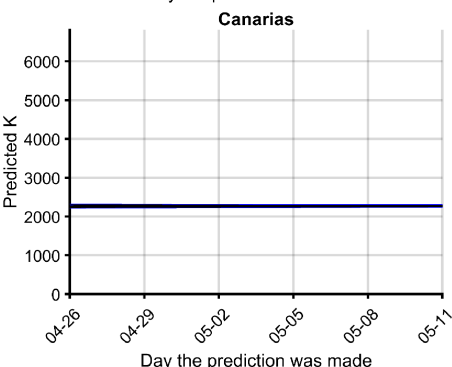
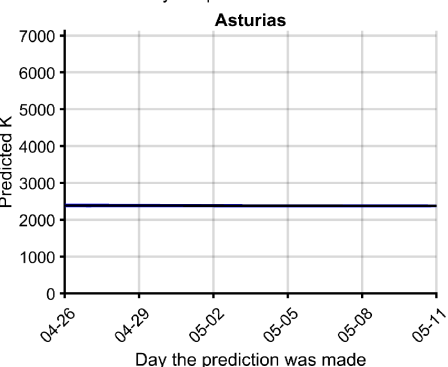
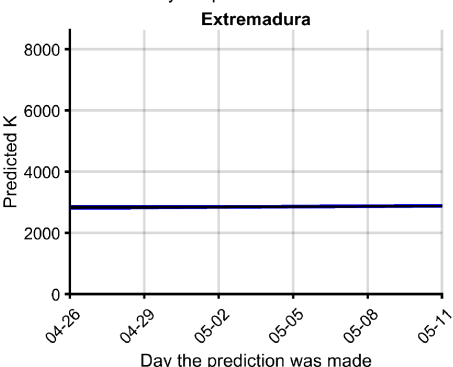
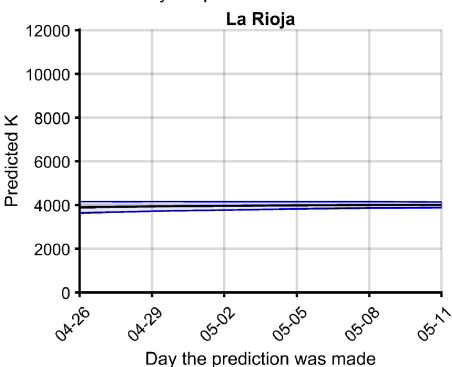
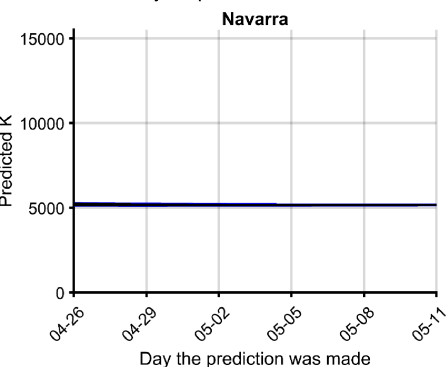
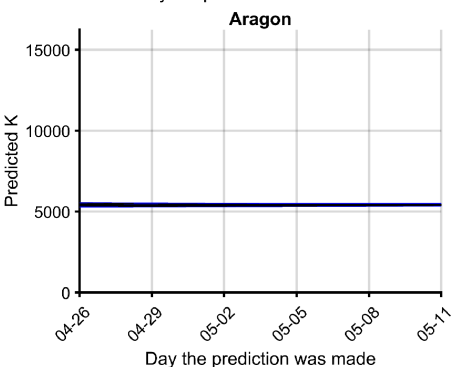
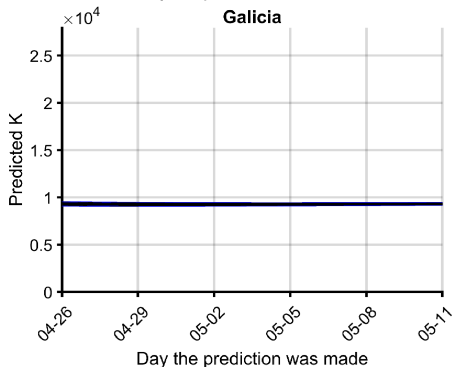
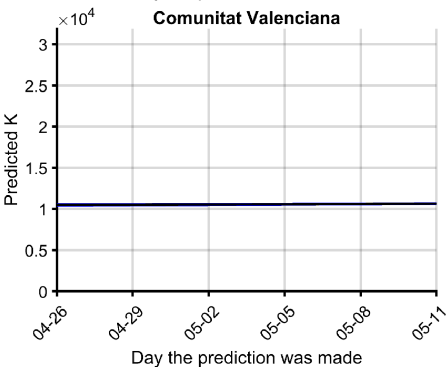
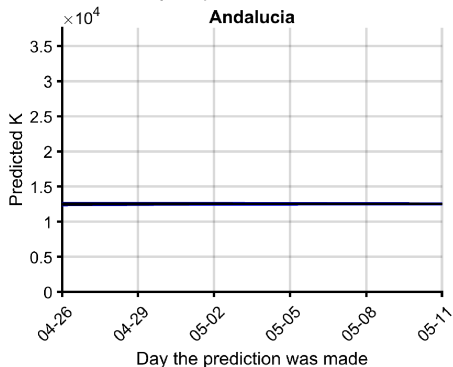
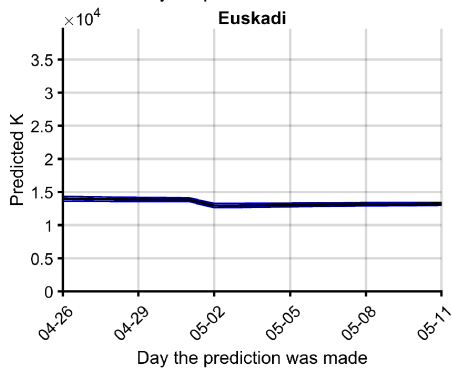
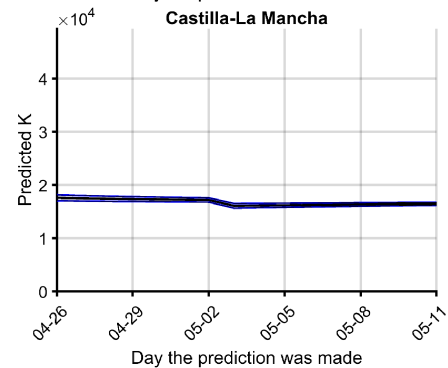
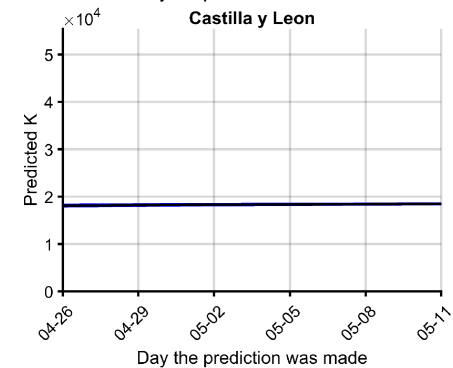
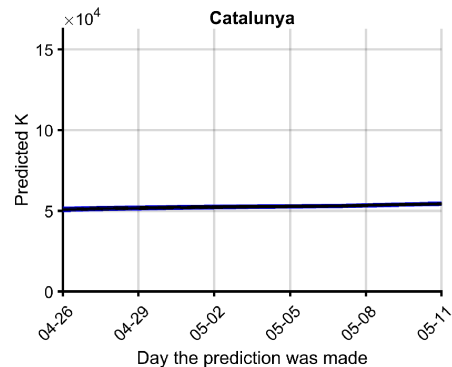
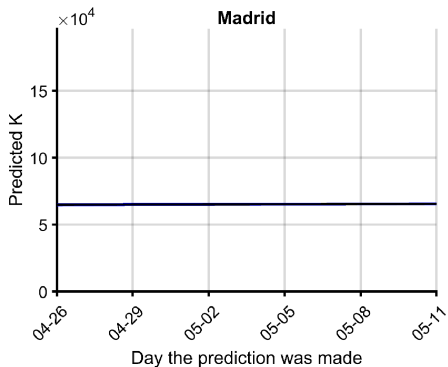
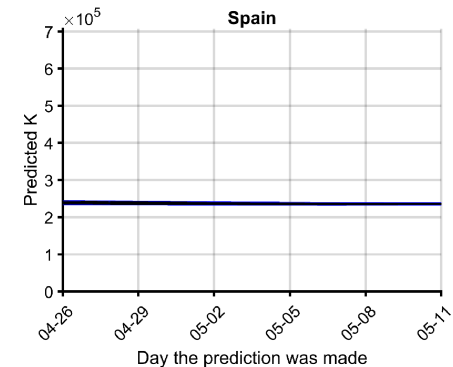
Spanish regions



2020-05-13



2020-05-12



Situation and trends in Italian and Spanish regions

Italy

Country	Reported data						Indexes		
	Cumulative cases	Attack rate / 10 ⁵ inh.	Cumulative deaths	Mortality / 10 ⁵ inh.	Active cases (last 14 days)	14-day attack rate / 10 ⁵ inh.	$\rho_7^{(1)}$	EPG _{REP} ⁽²⁾	EPG _{EST} ⁽³⁾
Lombardia	83.298	829,5	15.185	151,2	8.164	81,3	0,94	76	1.438
Piemonte	29.058	667,0	3.460	79,4	3.197	73,4	0,65	48	581
Emilia Romagna	26.979	605,0	3.905	87,6	1.802	40,4	0,63	25	372
Veneto	18.813	383,5	1.712	34,9	988	20,1	0,64	13	121
Toscana	9.829	263,5	964	25,8	537	14,4	0,60	9	87
Liguria	8.930	575,9	1.314	84,7	1.041	67,1	0,63	43	641
Lazio	7.250	123,3	577	9,8	705	12,0	0,70	8	69
Marche	6.588	431,9	971	63,7	378	24,8	0,86	21	322
Campania	4.630	79,8	394	6,8	220	3,8	0,84	3	28
Puglia	4.348	107,9	460	11,4	319	7,9	1,13	9	98
Trento	4.312	402,1	446	41,6	243	22,7	0,31	7	145
Sicilia	3.354	67,1	262	5,2	214	4,3	0,68	3	23
Friuli Venezia Giulia	3.156	259,7	316	26,0	146	12,0	0,81	10	99
Abruzzo	3.127	238,4	375	28,6	204	15,6	0,75	12	146
Bolzano	2.575	2.396,8	290	269,9	68	63,3	1,20	76	174
Umbria	1.419	160,9	72	8,2	28	3,2	1,96	6	NA
Sardegna	1.345	82,0	120	7,3	55	3,4	2,05	7	61
Valle d'Aosta	1.163	925,9	141	112,3	39	31,0	0,91	28	351
Calabria	1.140	58,5	93	4,8	38	2,0	1,07	2	NA
Molise	401	131,2	22	7,2	104	34,0	3,17	108	NA
Basilicata	389	69,1	27	4,8	23	4,1	NA	NA	NA

Scale									
Worst	Worst	Worst	Worst	Worst	Worst	Worst	2,0	200	2000
Best	Best	Best	Best	Best	Best	Best	0,0	0	0

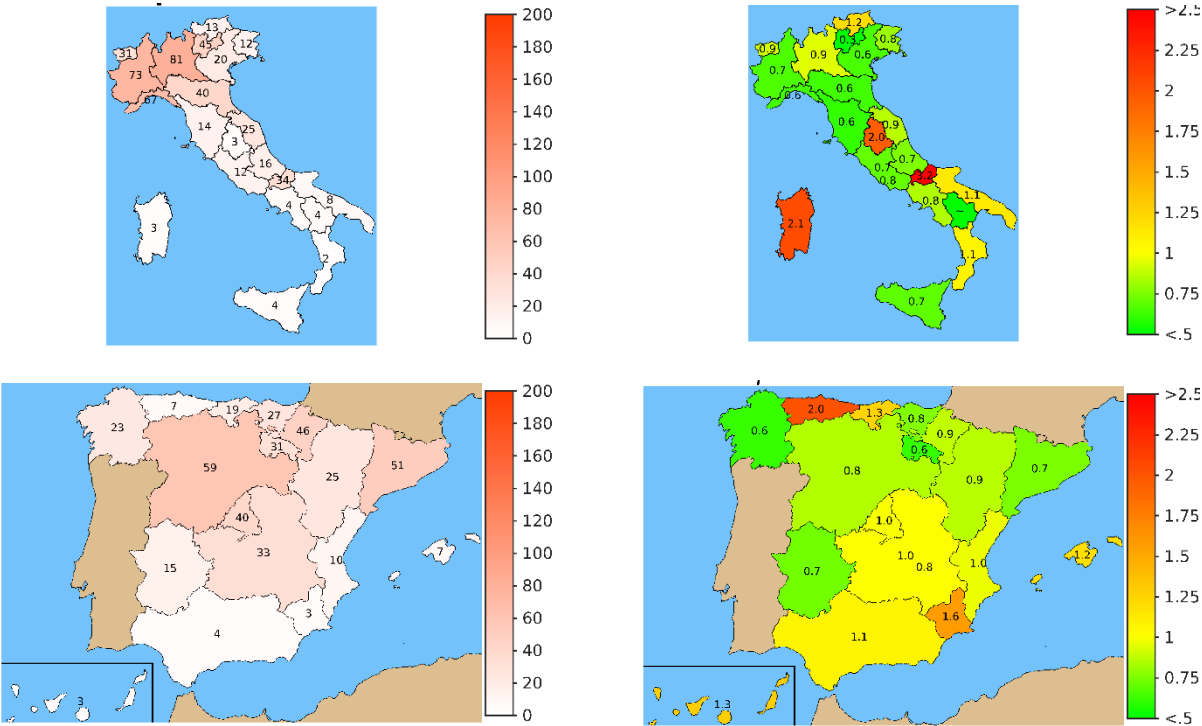
Spain

Autonomous regions	Reported data						Indexes		
	Cumulative cases	Attack rate / 10 ⁵ inh.	Cumulated deaths	Mortality rate / 10 ⁵ inh.	Active cases (last 14 days)	14-day attack rate / 10 ⁵ inh.	$\rho_7^{(1)}$	EPG _{REP} ⁽²⁾	EPG _{EST} ⁽³⁾
Madrid	65.269	982,9	8.760	131,9	2.648	39,9	0,99	39	546
Catalunya	52.565	694,8	5.692	75,2	3.911	51,7	0,74	38	423
Castilla y Leon	18.105	751,8	1.919	79,7	1.415	58,8	0,85	50	532
Castilla-La Mancha	16.453	808,3	2.835	139,3	668	32,8	1,00	33	578
Euskadi	13.214	606,7	1.442	66,2	595	27,3	0,75	21	221
Andalucia	12.317	146,2	1.332	15,8	313	3,7	1,07	4	44
Comunitat Valenciana	10.760	216,3	1.341	27,0	524	10,5	0,97	10	124
Galicia	9.301	344,4	597	22,1	626	23,2	0,61	14	94
Aragon	5.372	406,7	829	62,8	330	25,0	0,86	22	340
Navarra	5.094	783,7	494	76,0	300	46,2	0,9	41	409
La Rioja	4.009	1.278,5	348	111,0	99	31,6	0,61	19	166
Extremadura	2.919	274,0	489	45,9	155	14,5	0,72	11	174
Asturias	2.356	230,5	307	30,0	67	6,6	2,02	13	176
Canarias	2.271	102,9	151	6,8	69	3,1	1,29	4	29
Cantabria	2.256	387,8	205	35,2	110	18,9	1,25	24	223
Baleares	1.957	164,8	215	18,1	78	6,6	1,2	8	92
Murcia	1.525	102,5	142	9,5	45	3,0	1,58	5	45
Melilla	119	140,5	2	2,4	5	5,9	NA	NA	NA
Ceuta	114	134,4	4	4,7	13	15,3	NA	NA	NA

Scale									
Worst	Worst	Worst	Worst	Worst	Worst	Worst	2,0	200	2000
Best	Best	Best	Best	Best	Best	Best	0,0	0	0

⁽¹⁾ ρ_7 is the average of 7 consecutive ρ , but can still fluctuate. ⁽²⁾ EPG stands for Effective Growth Potential. EPG_{REP} is obtained by multiplying attack rate of last 14 days per 10⁵ inhabitants (i.e. density of cases) by ρ_7 (a value related with effective reproduction number and that, therefore, determines the dynamics for subsequent days). EPG_{EST} is obtained by multiplying estimated real attack rate of last 14 days per 10⁵ inhabitants by ρ_7 .

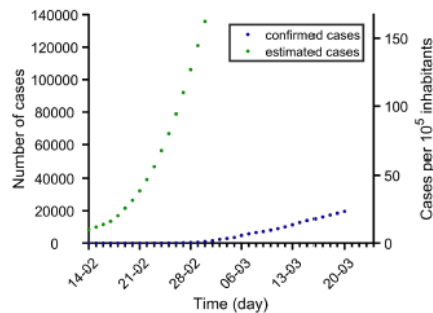
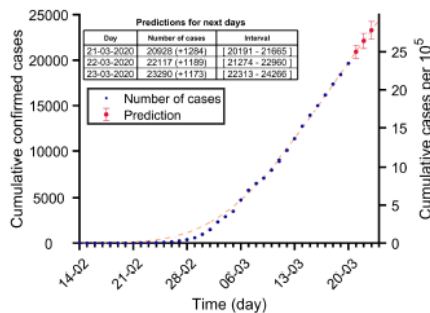
The **maps** in the left show current A_{14} . The maps in the right shows current p_7 .



Legend: Countries' reports details

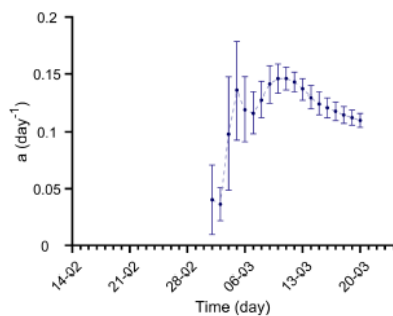
Iran 20-03-2020. Population: 83.7M. Current cumulated incidence: $23/10^5$

Confirmed cases:
data (blue),
model fitted
(dashed line),
predictions (red
points and table)

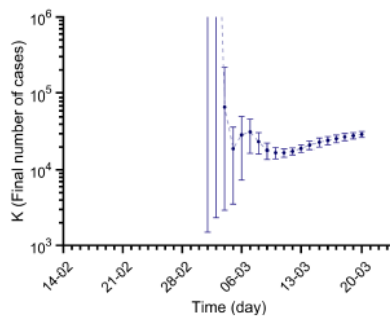


Estimated
cases using
death rate (see
Methods)

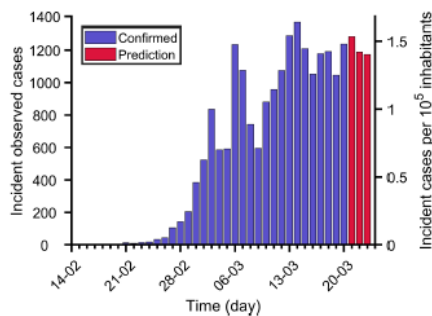
Fitted a value
using points
prior to each
date



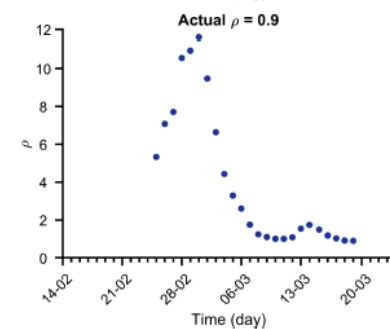
Fitted K value
using points
prior to each
date



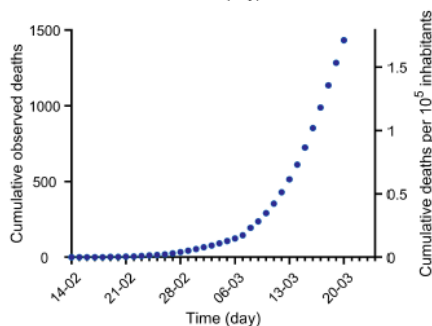
Reported
and
predicted
new cases



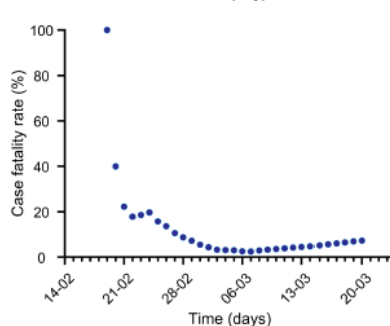
Evolution of ρ , a
parameter related
with Reproduction
number (see
Methods)



Reported
deaths

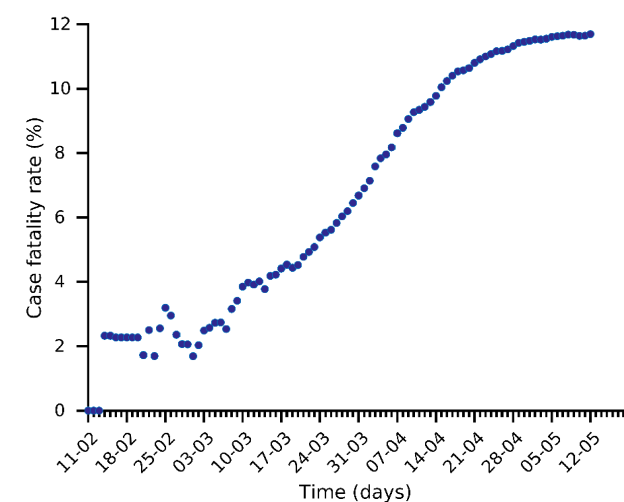
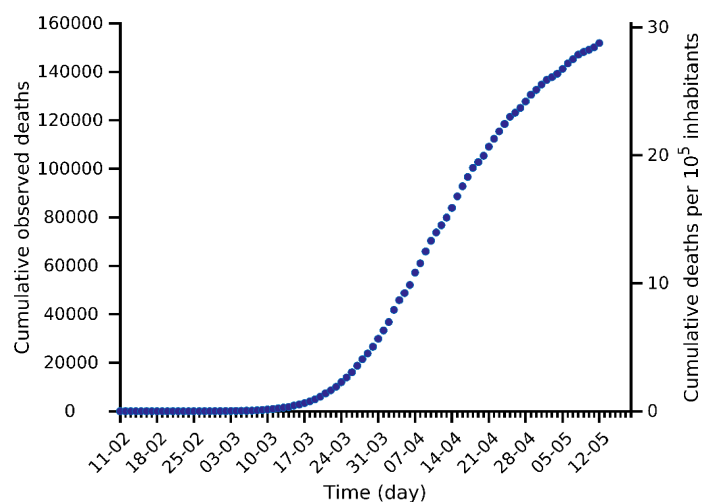
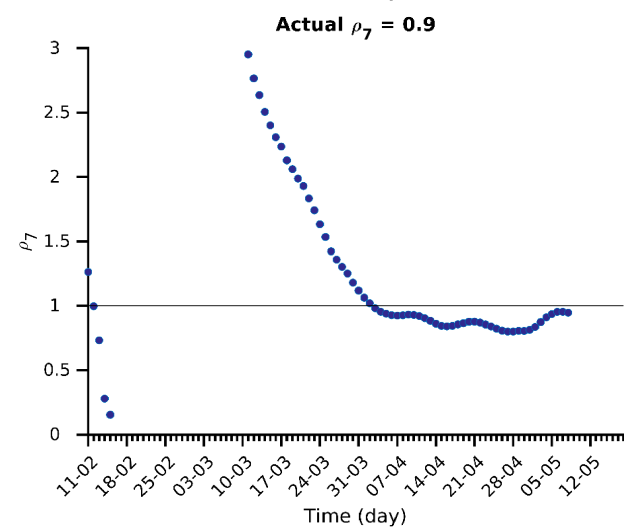
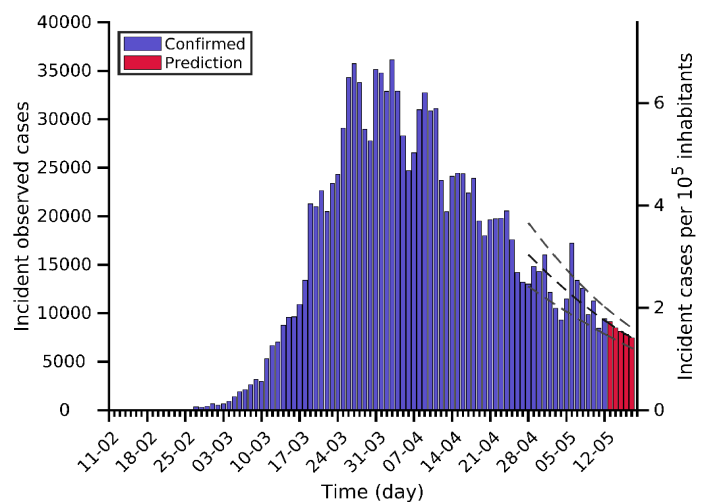
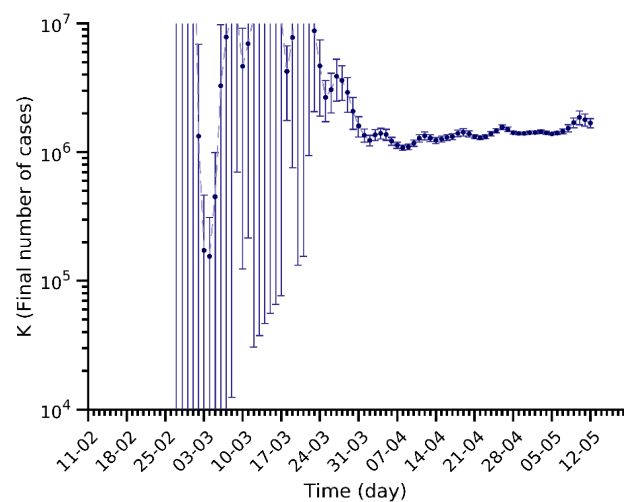
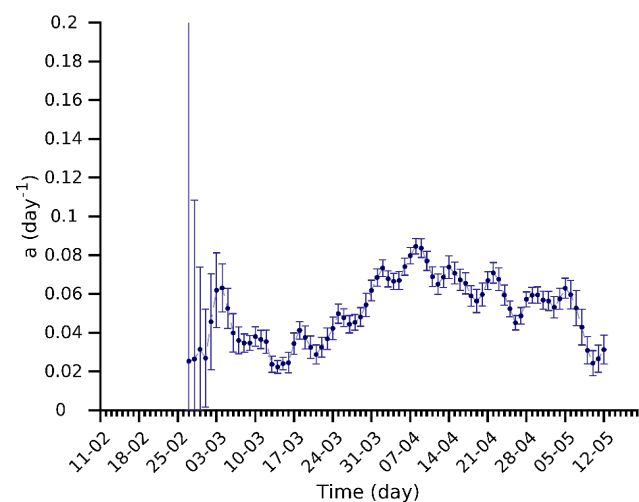
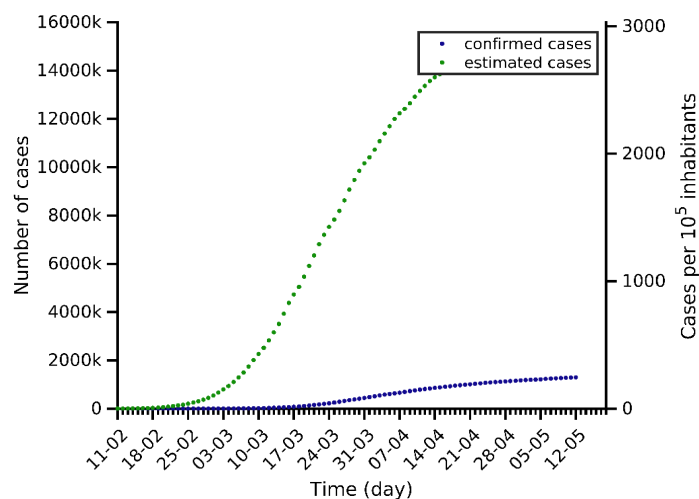
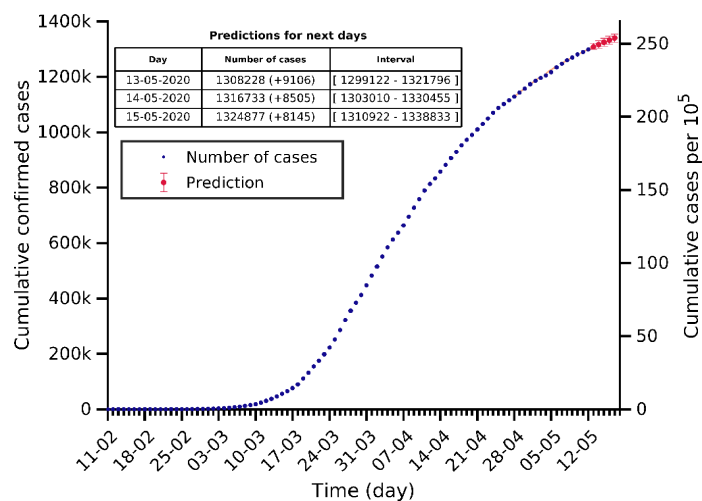


Deaths /
cumulated
reported cases

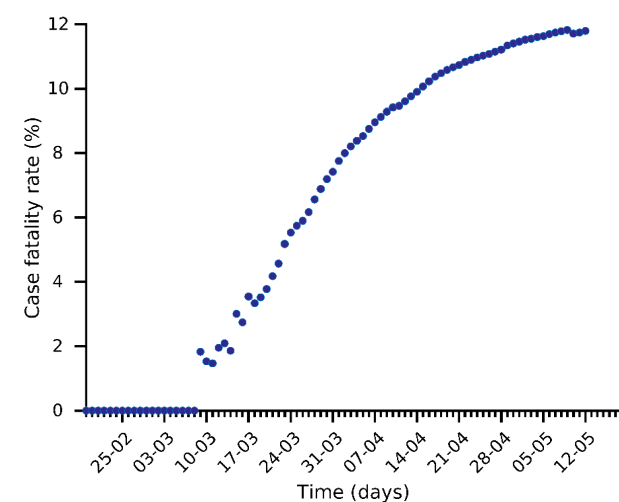
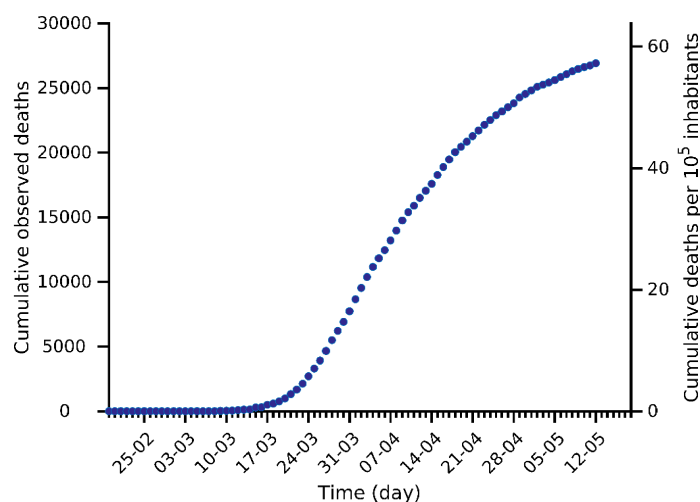
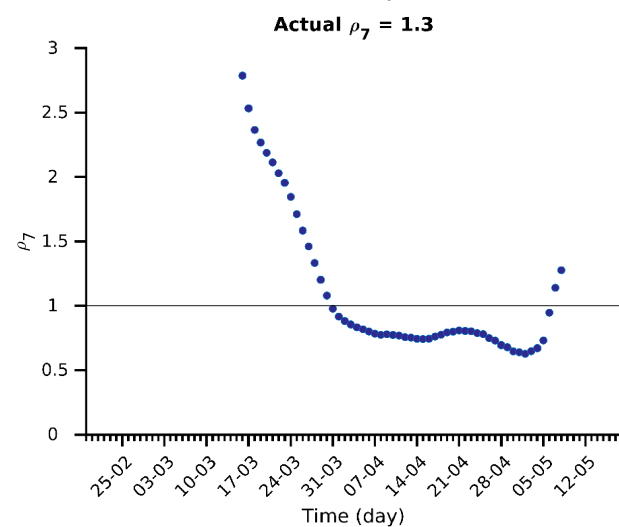
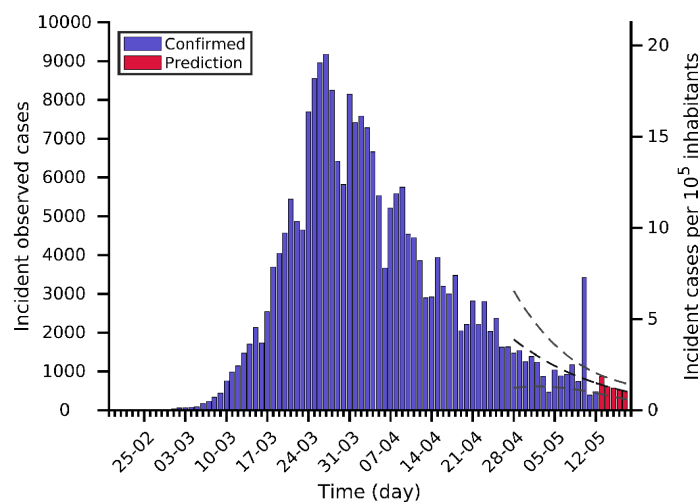
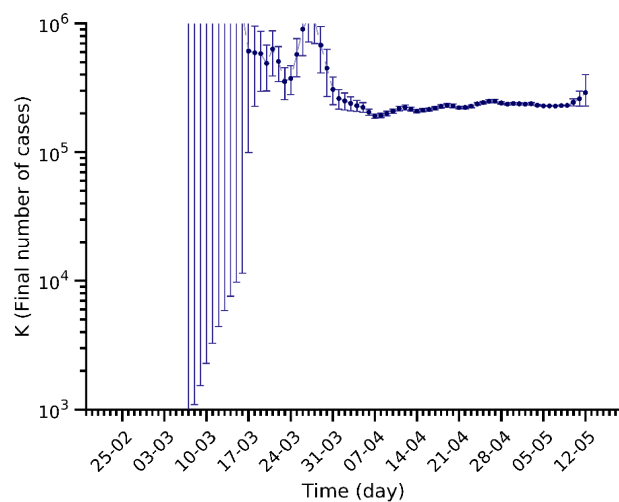
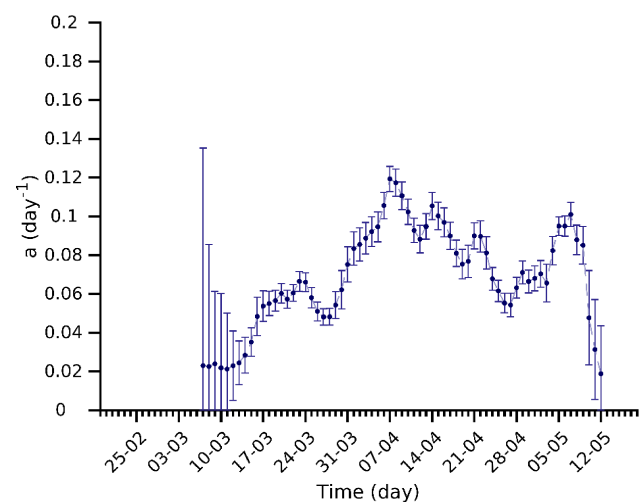
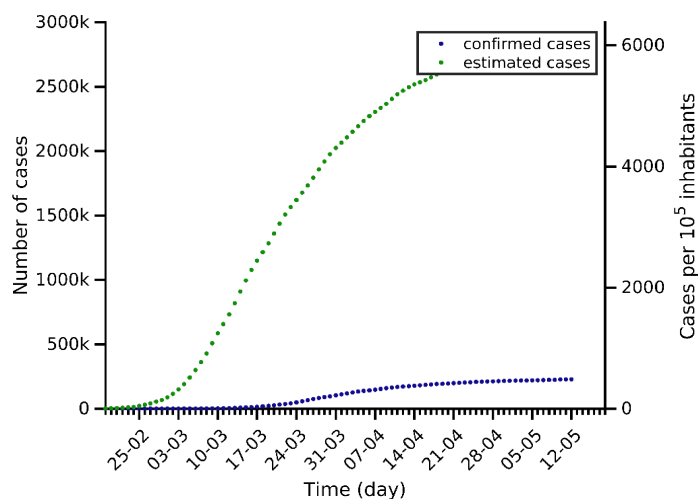
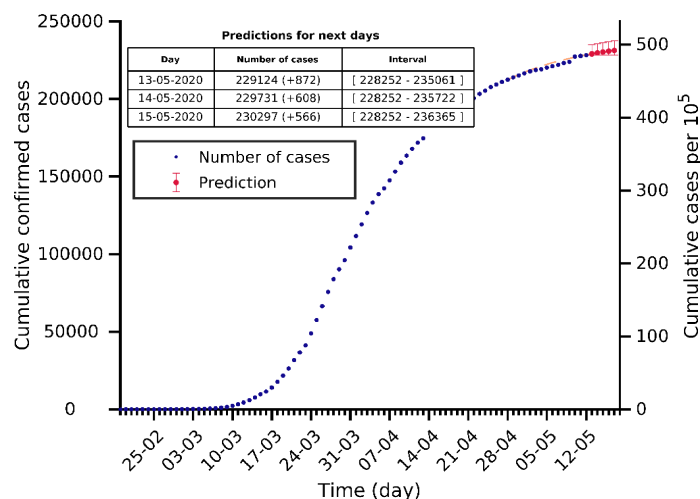


(1) Analysis and prediction of COVID-19 for EU+EFTA+UK

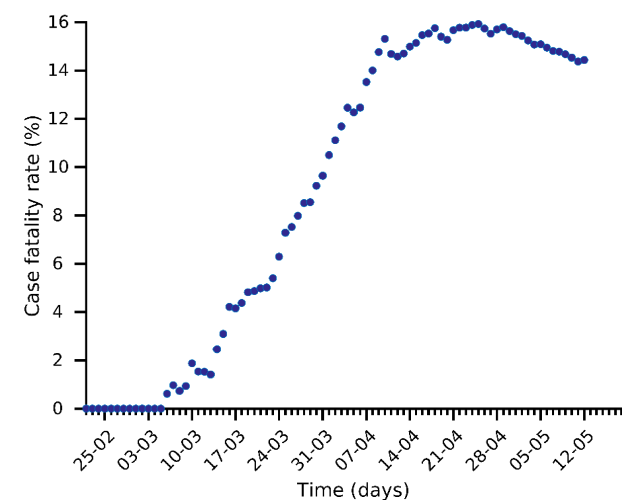
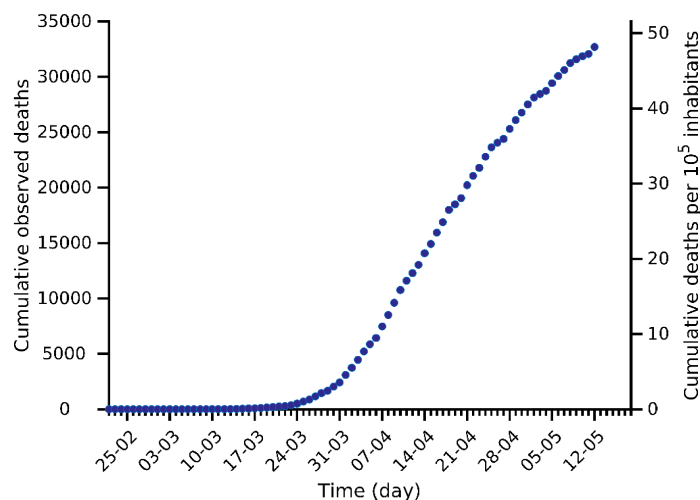
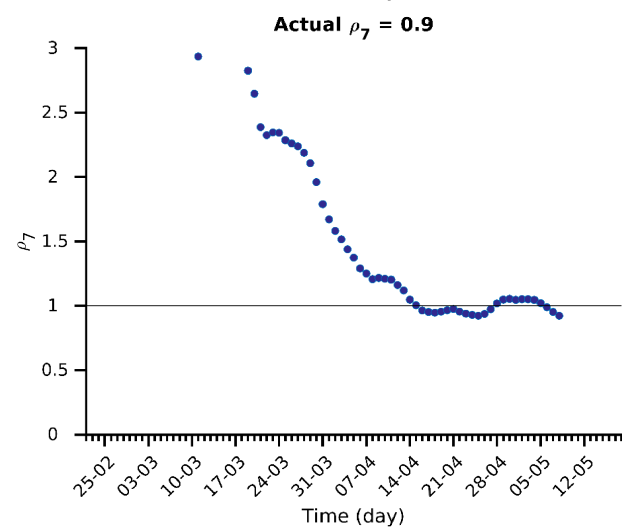
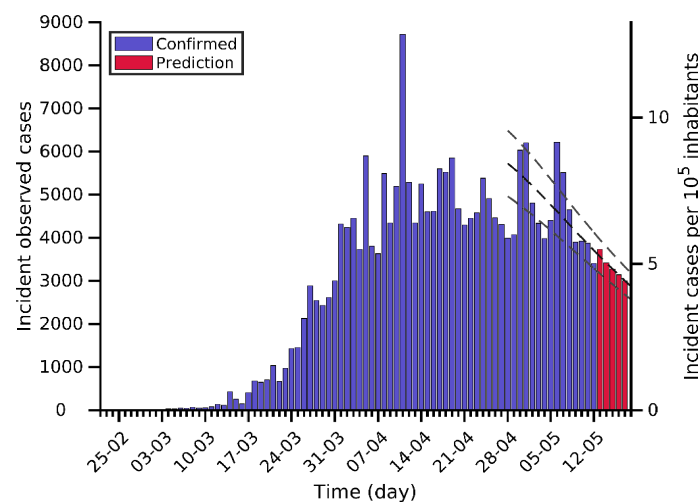
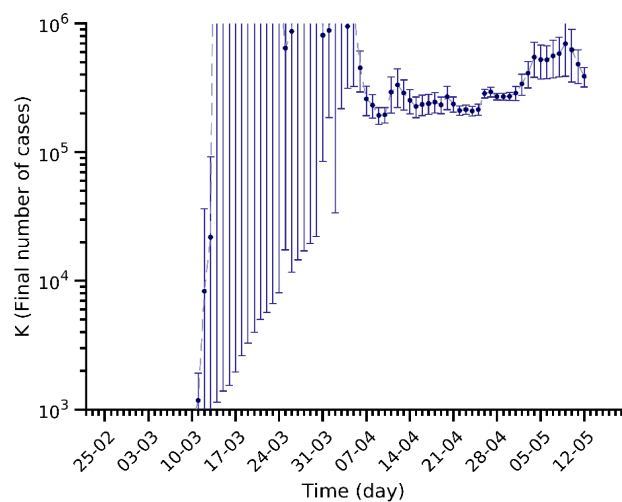
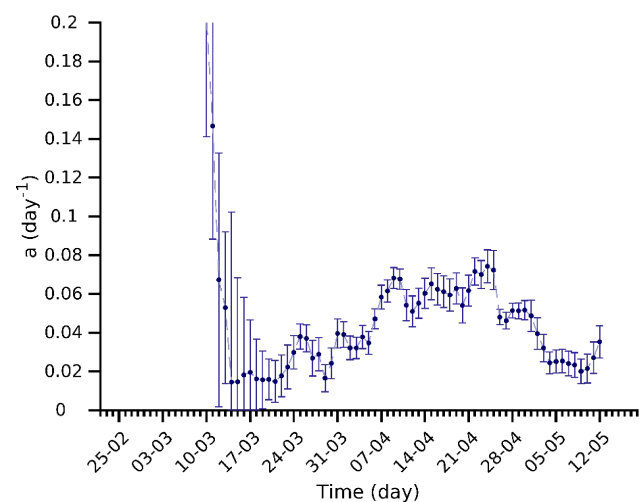
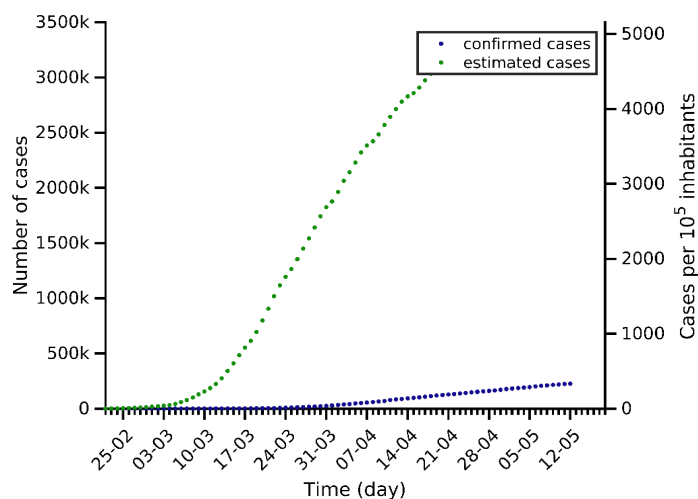
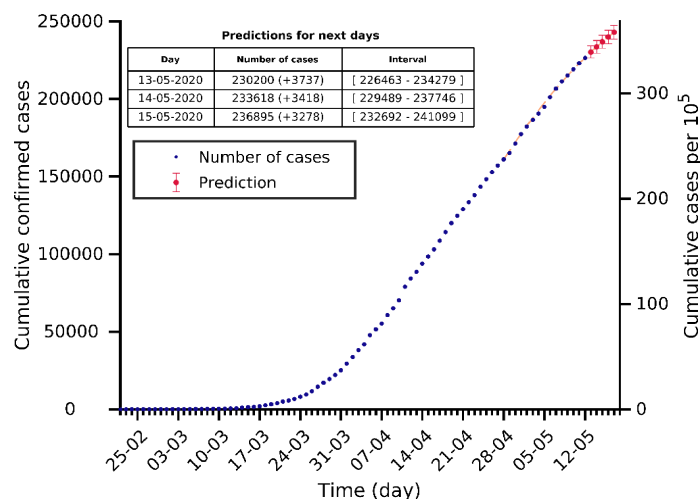
Data obtained from <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>



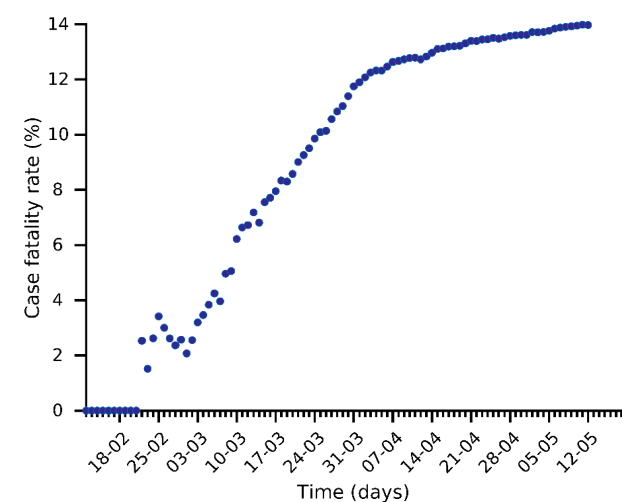
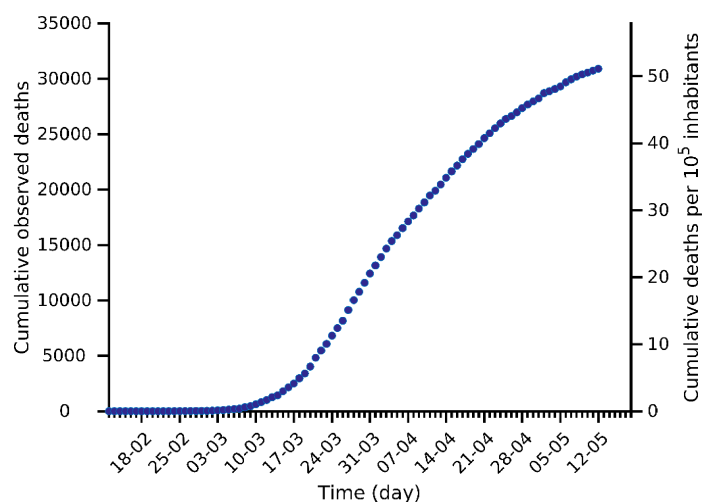
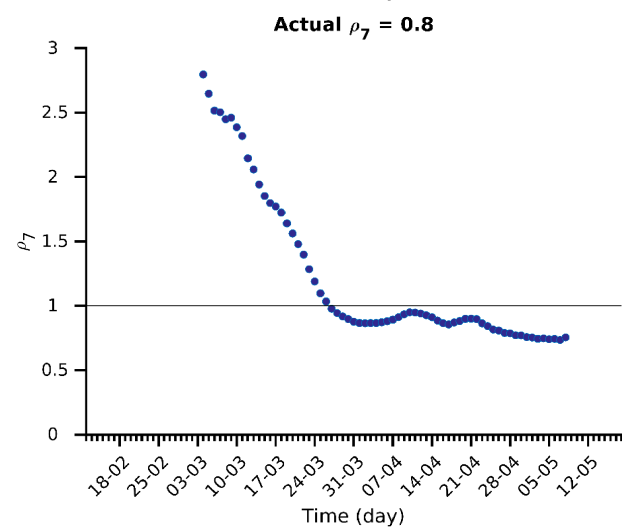
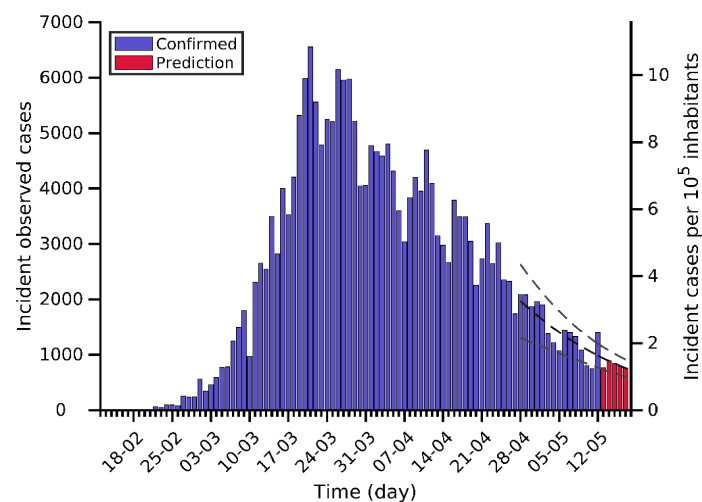
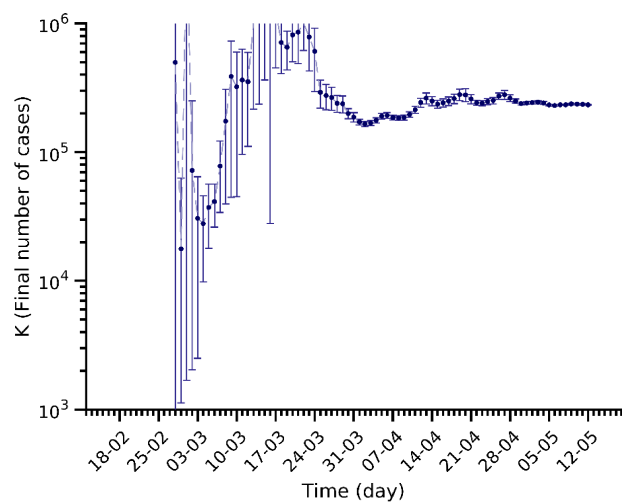
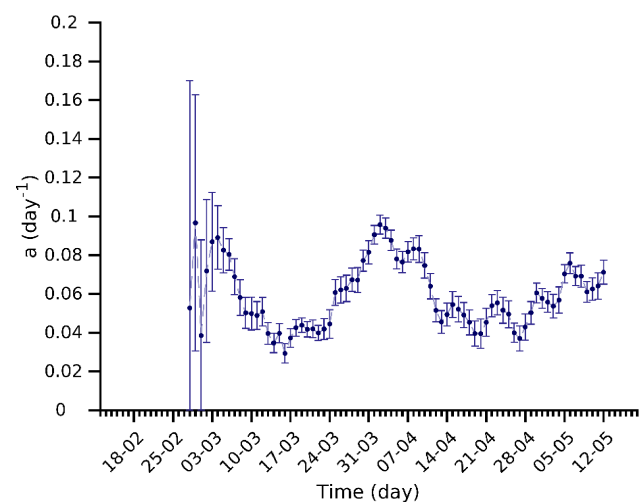
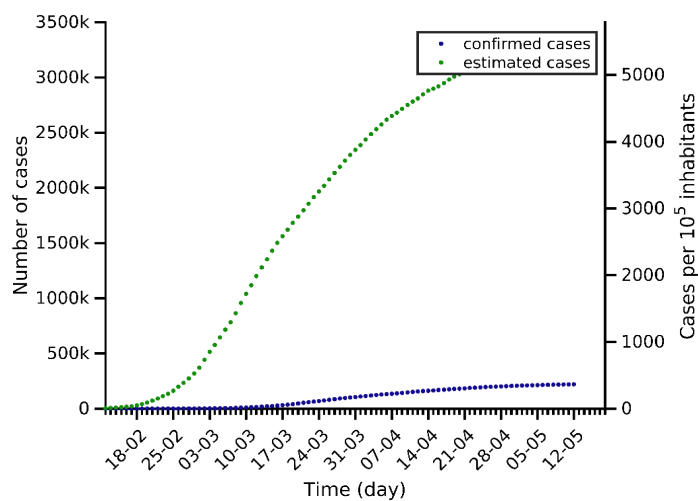
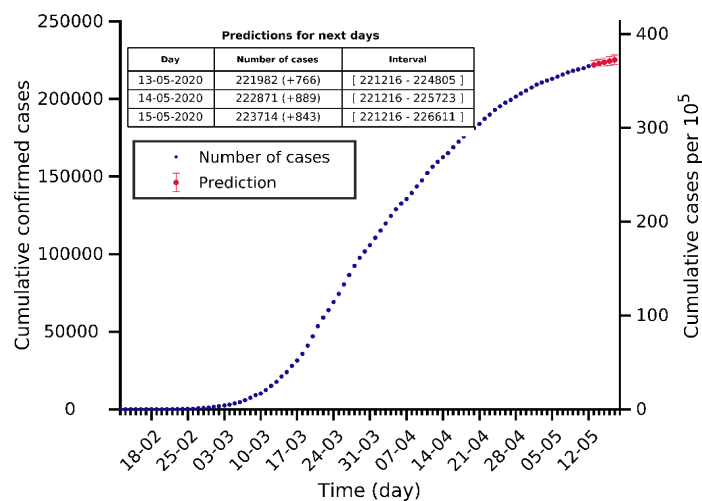
Spain 12-05-2020. Population: 47.0M. Current cumulated incidence: 485/10⁵



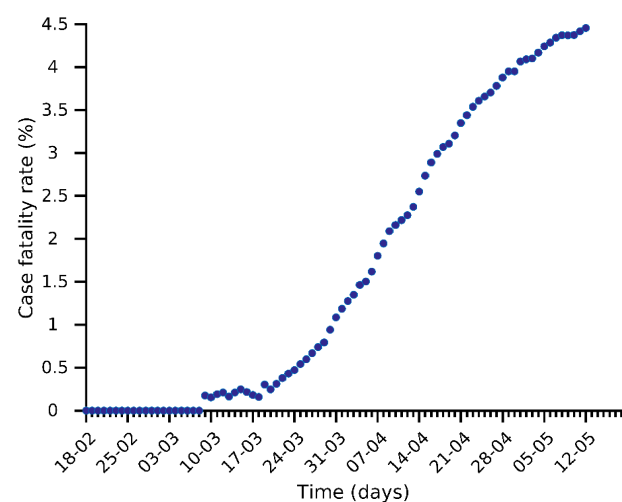
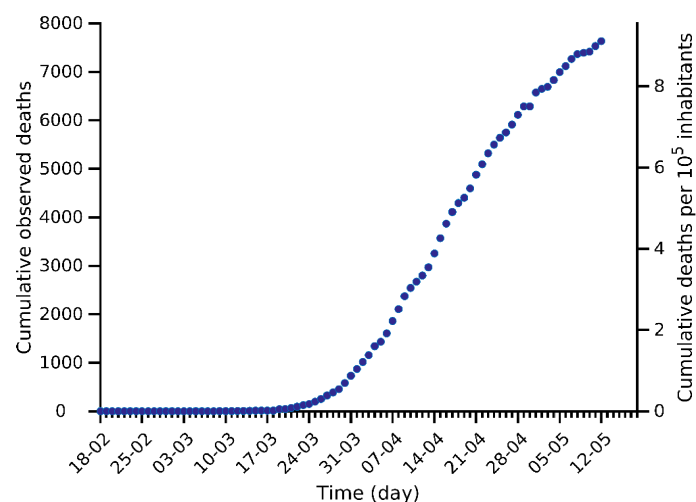
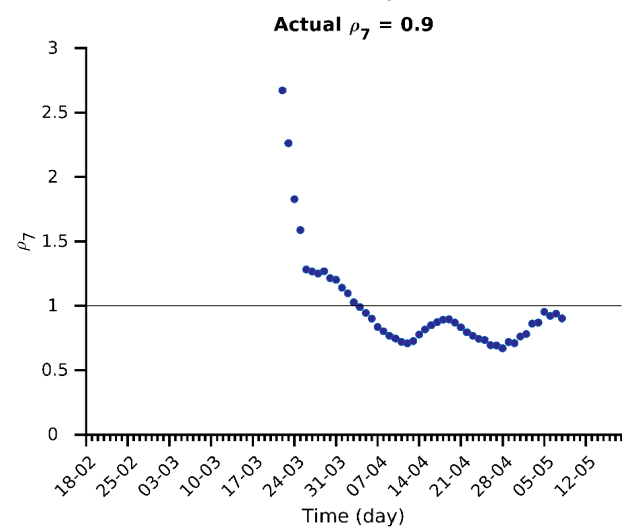
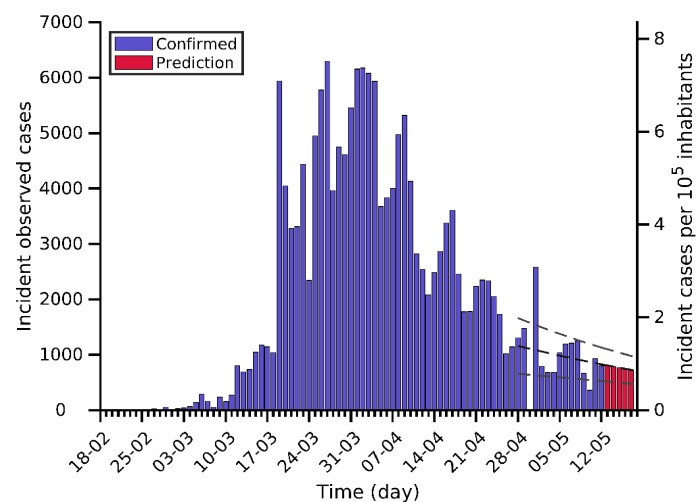
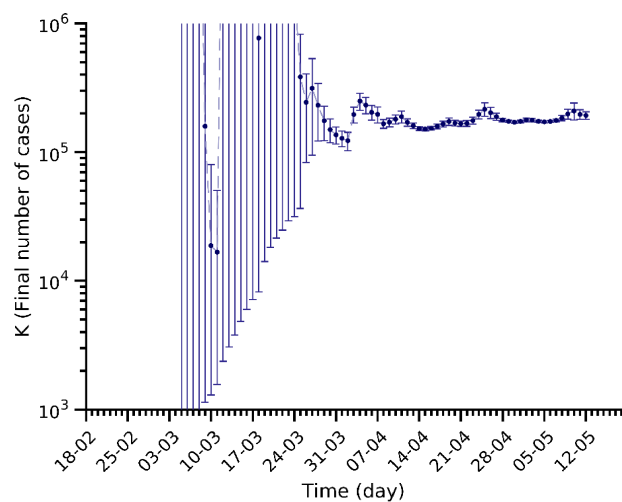
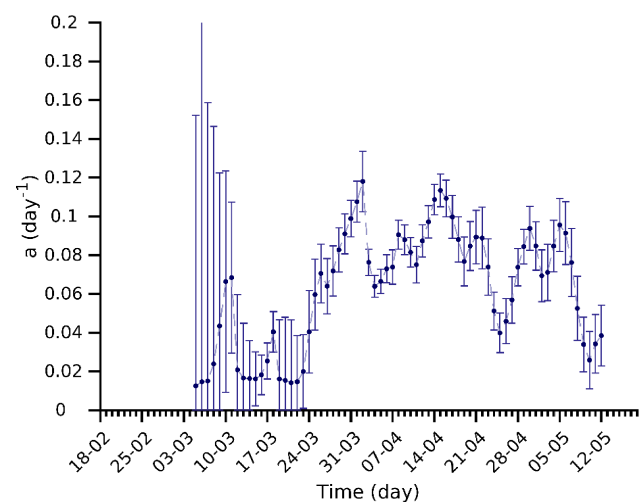
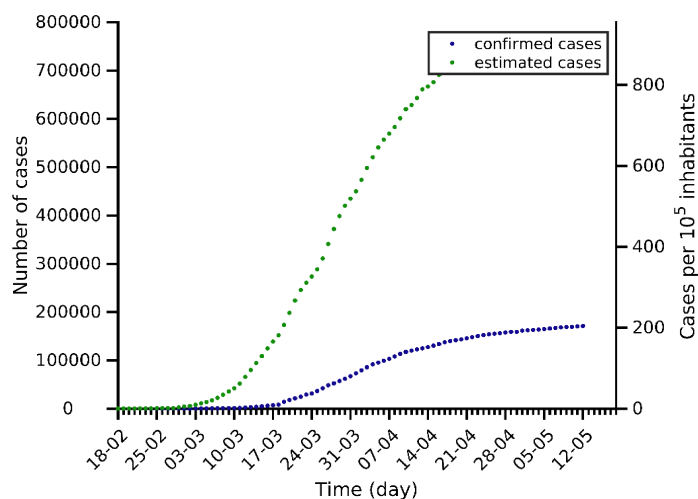
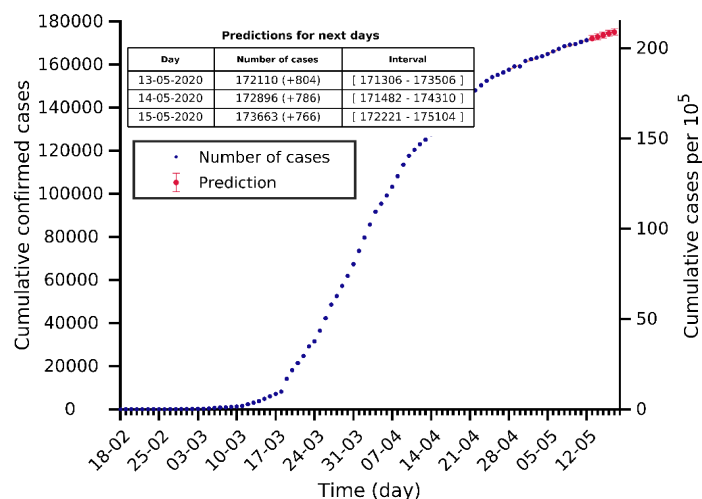
UK 12-05-2020. Population: 67.9M. Current cumulated incidence: 334/10⁵



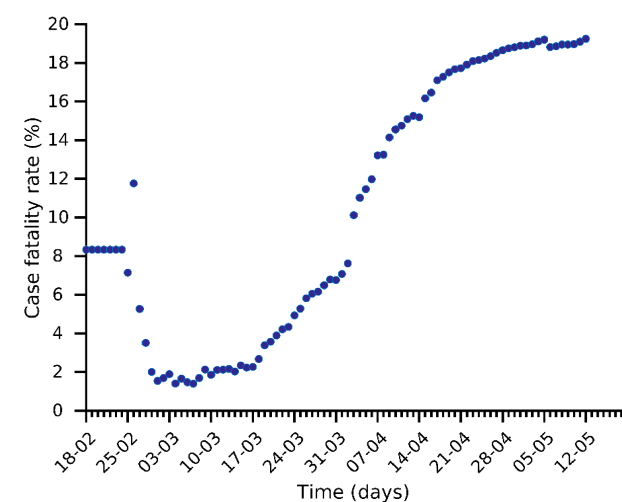
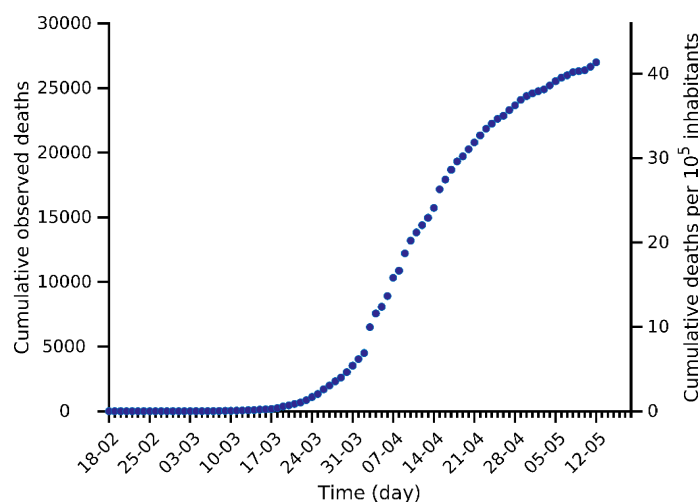
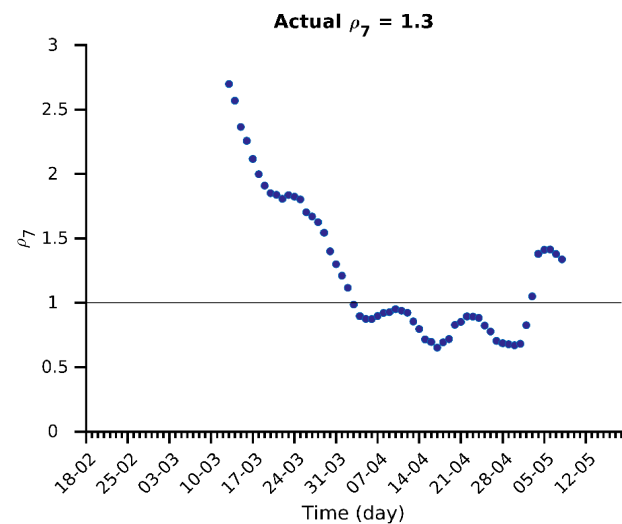
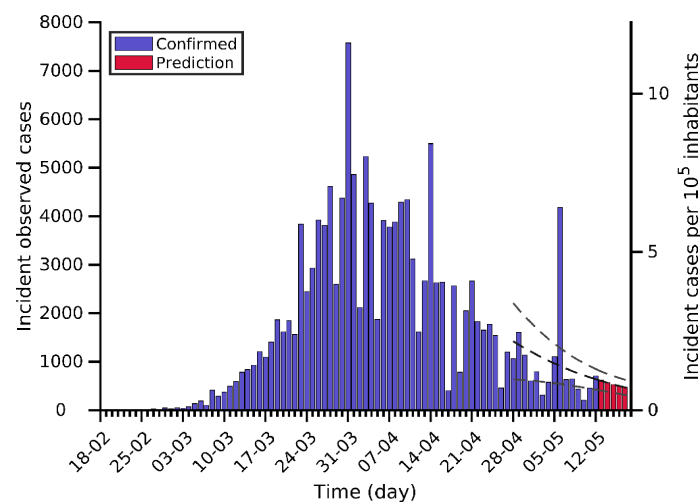
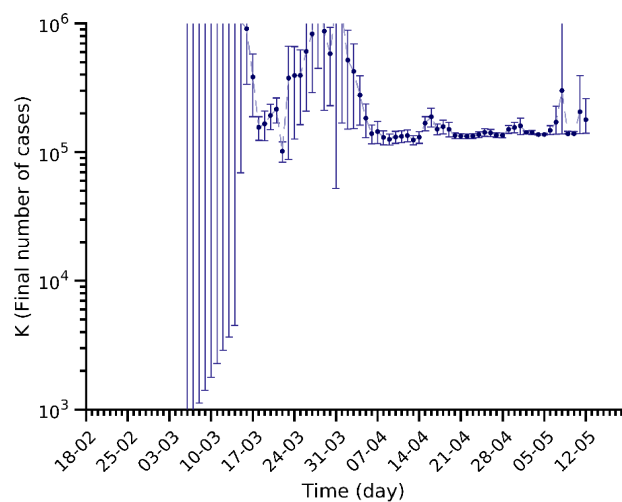
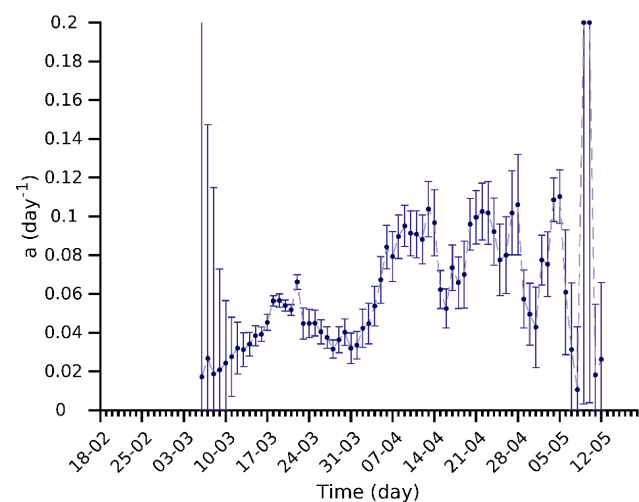
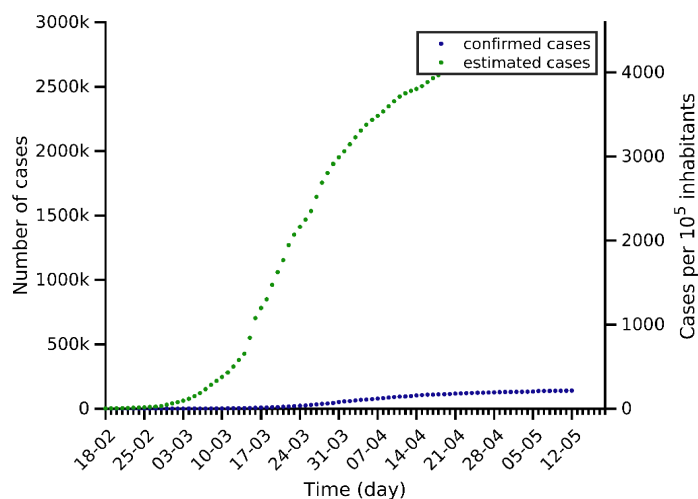
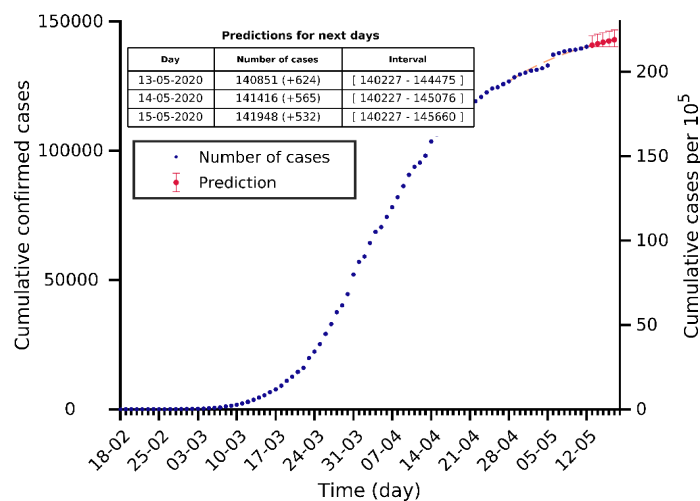
Italy 12-05-2020. Population: 60.5M. Current cumulated incidence: 366/10⁵



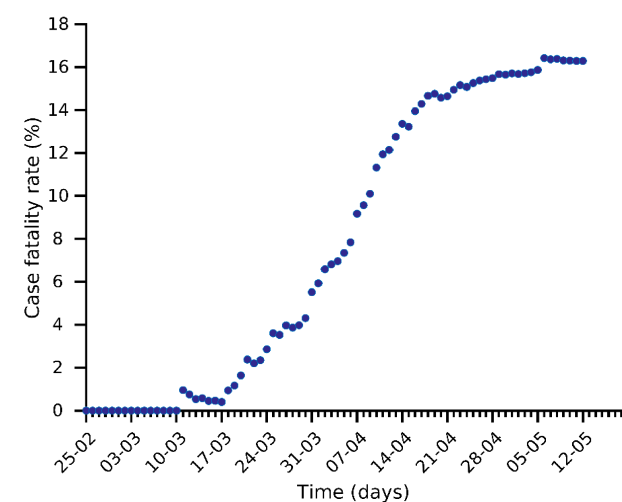
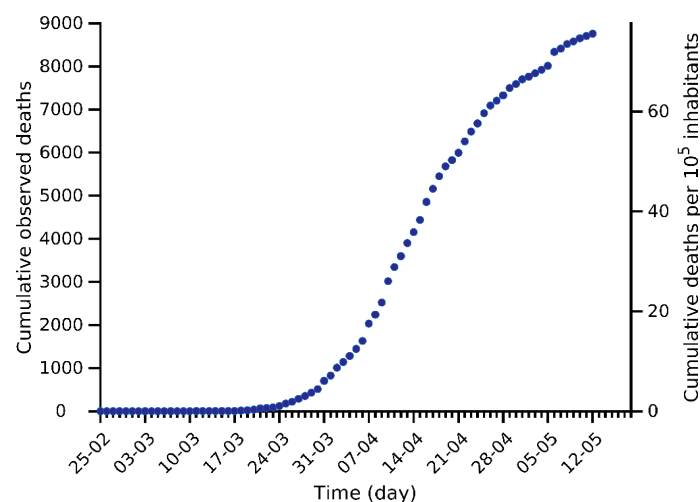
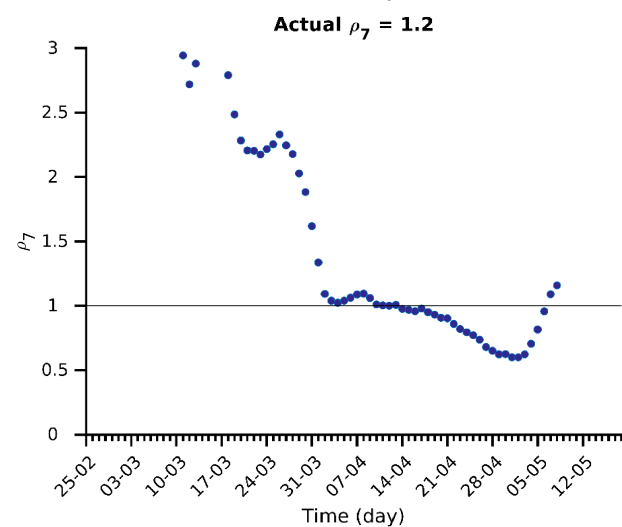
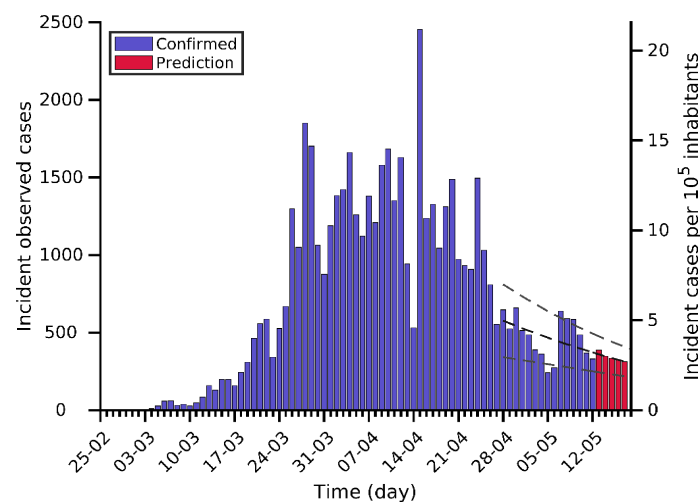
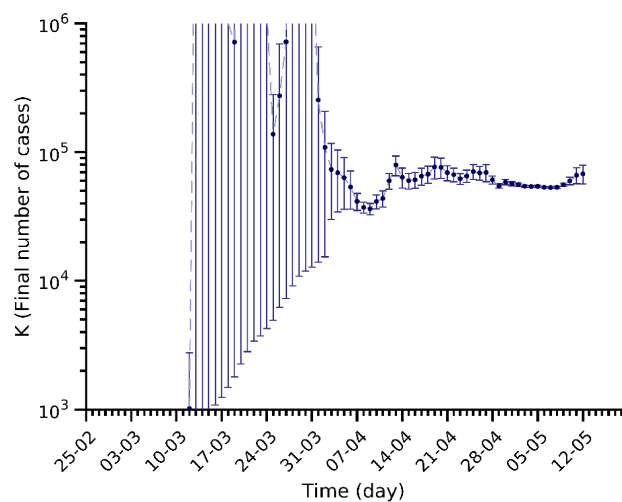
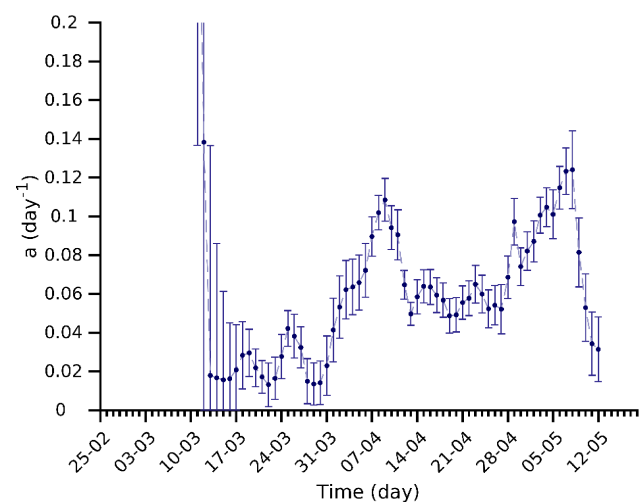
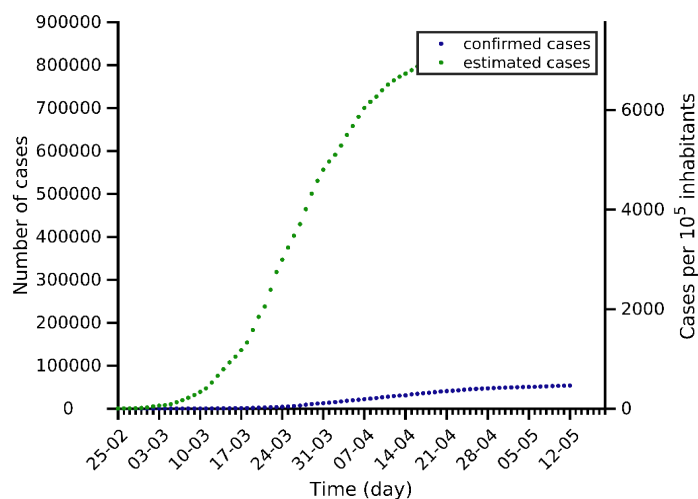
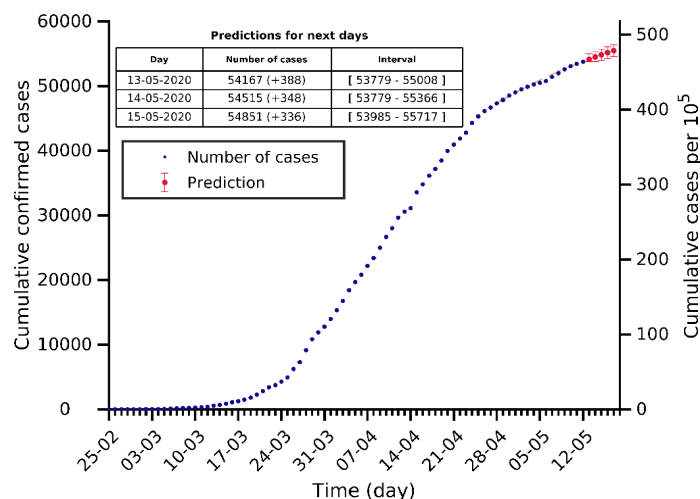
Germany 12-05-2020. Population: 83.8M. Current cumulated incidence: 204/10⁵



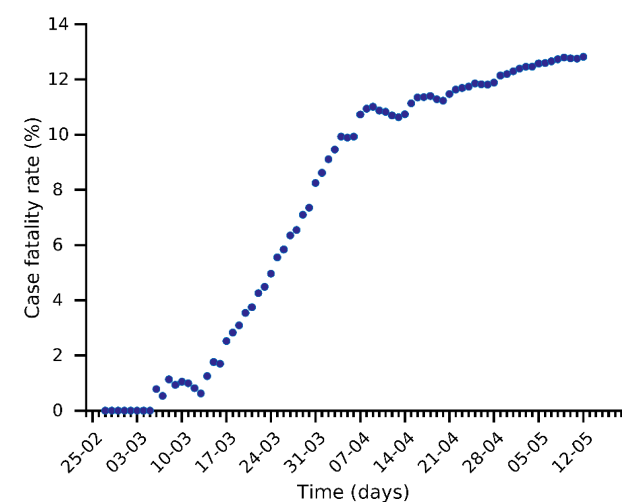
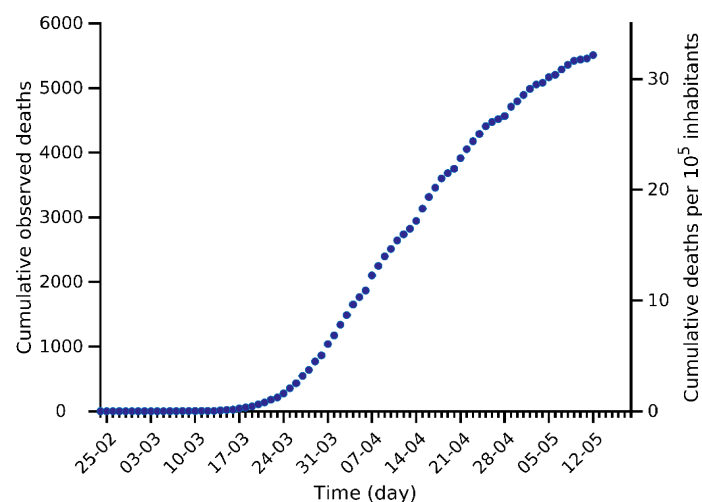
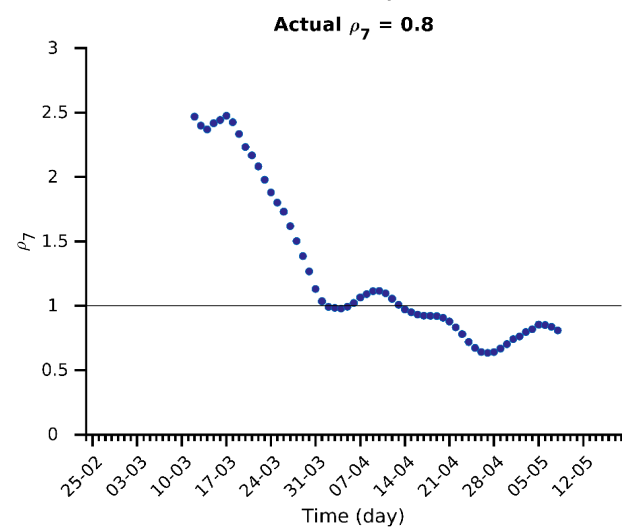
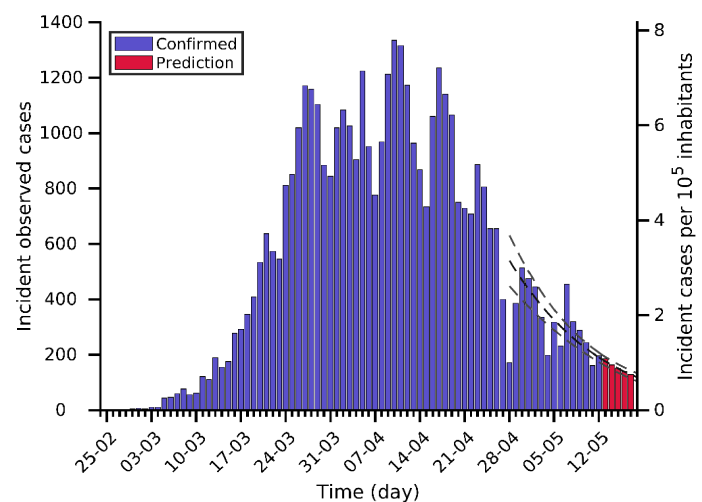
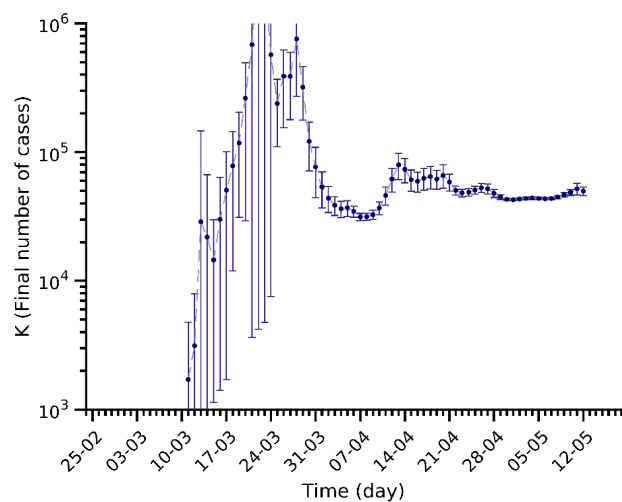
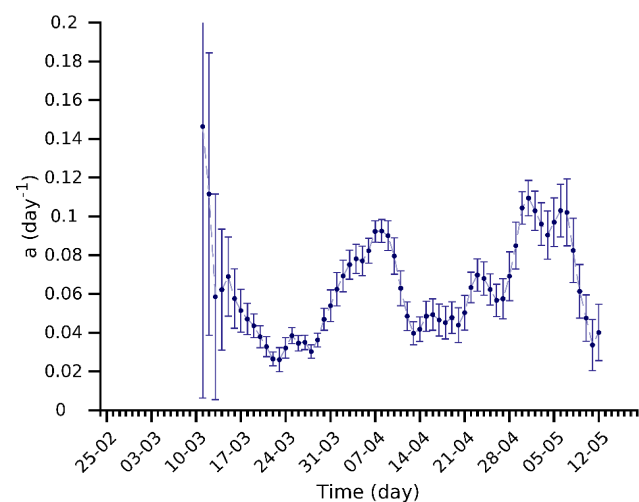
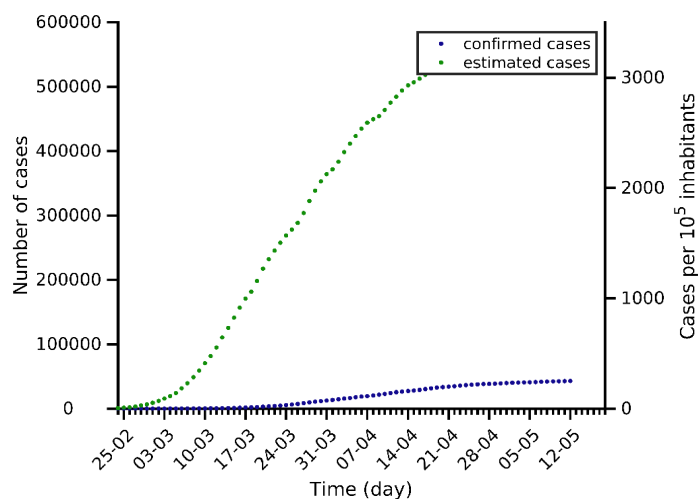
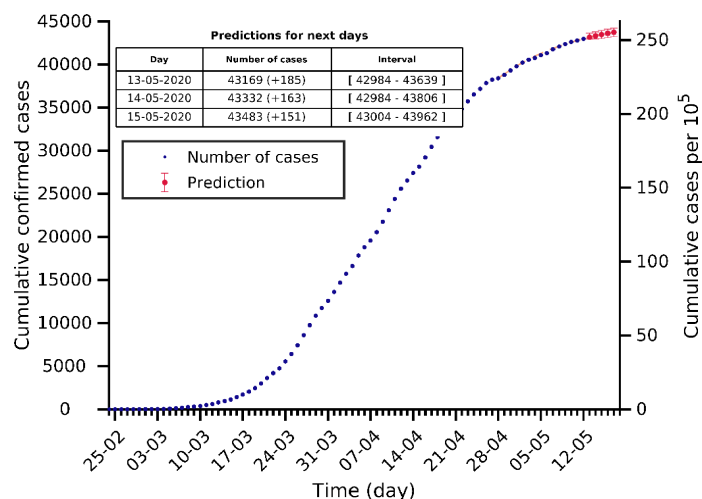
France 12-05-2020. Population: 65.3M. Current cumulated incidence: 215/10⁵



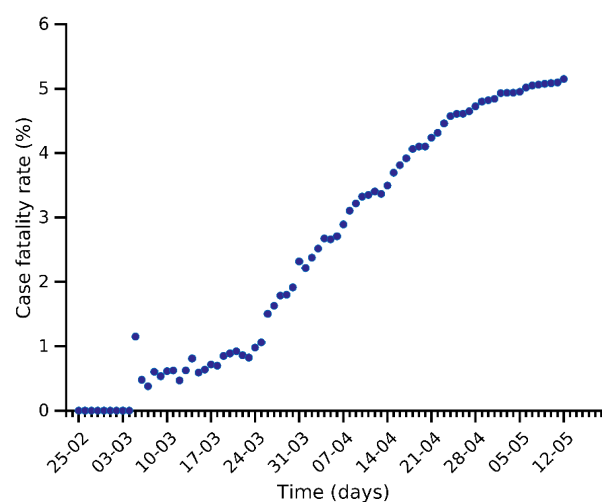
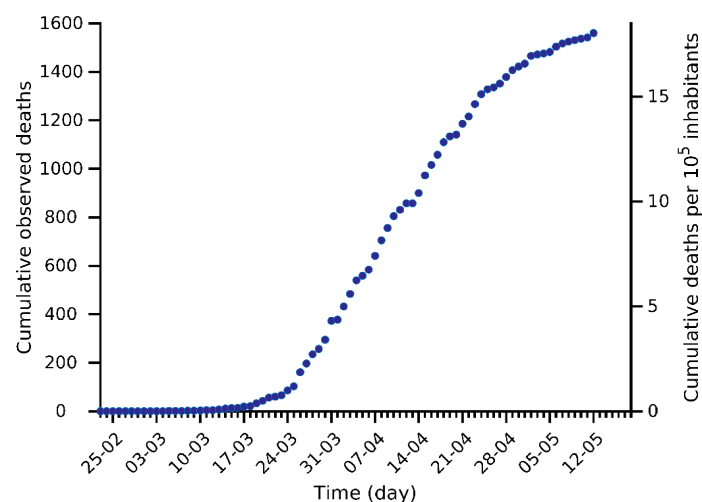
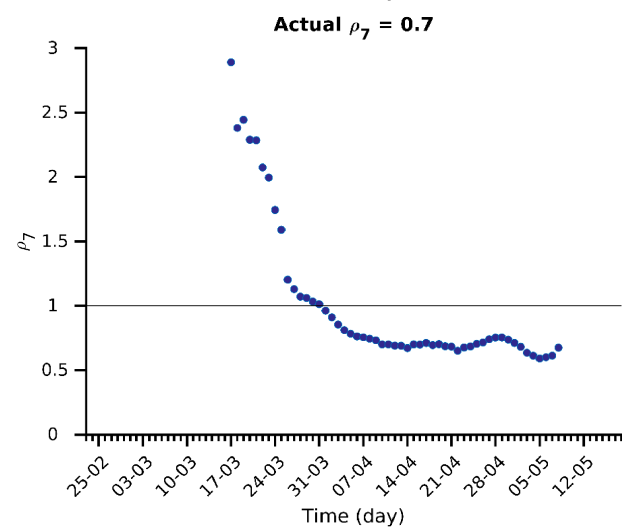
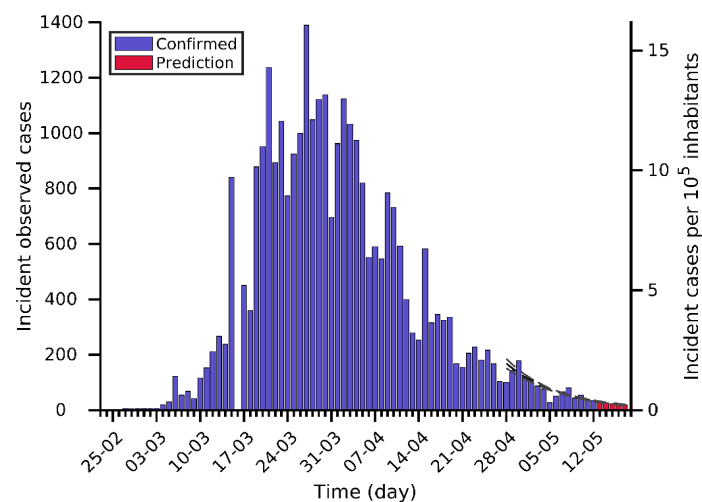
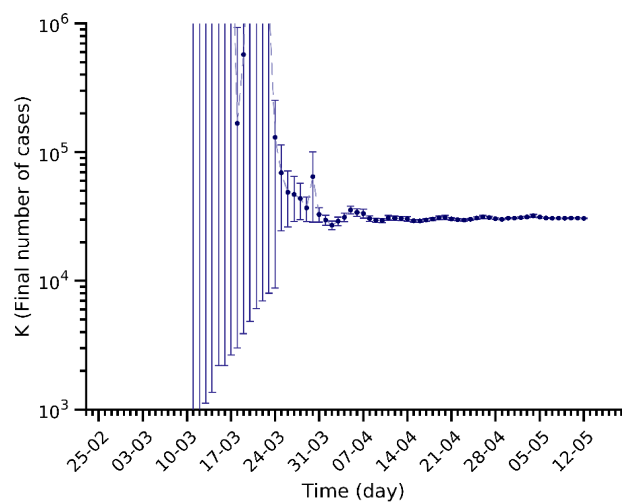
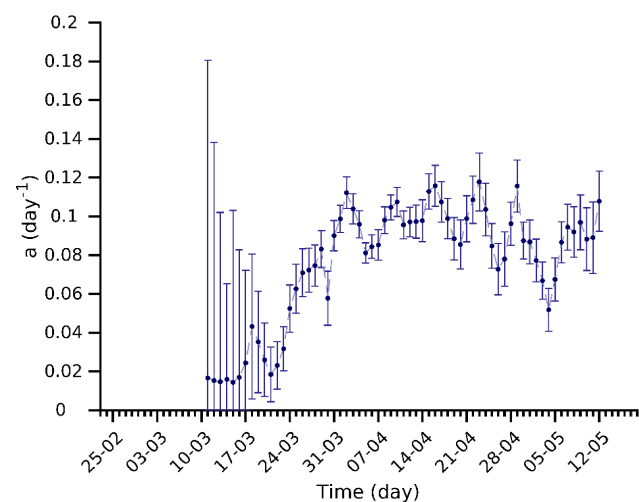
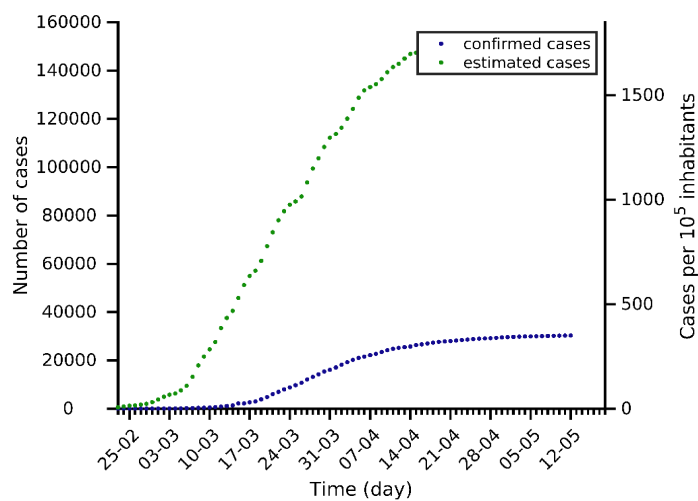
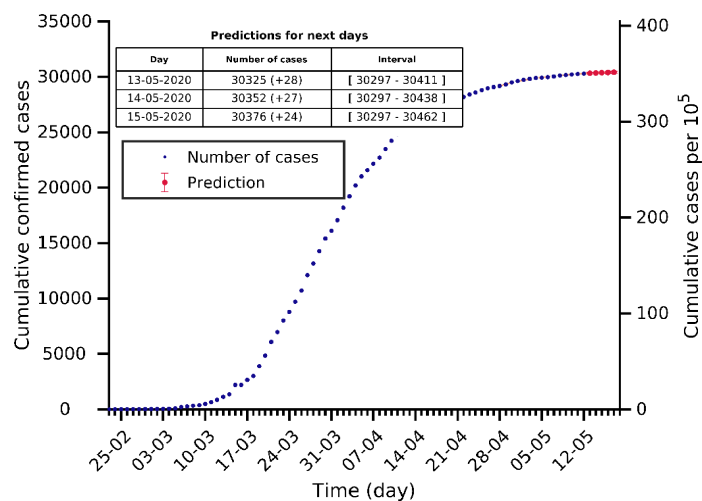
Belgium 12-05-2020. Population: 11.6M. Current cumulated incidence: 464/10⁵



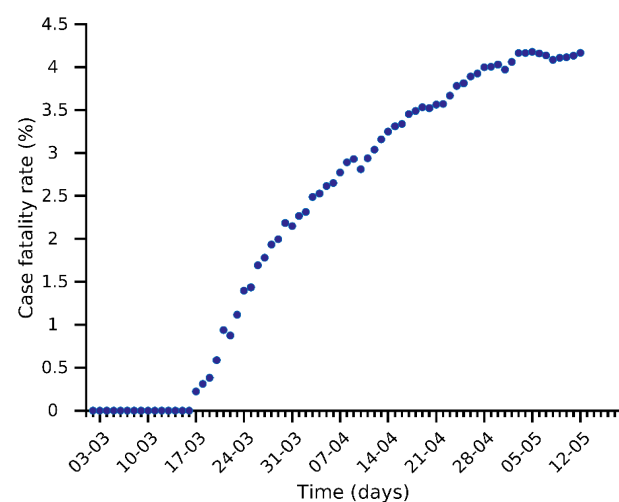
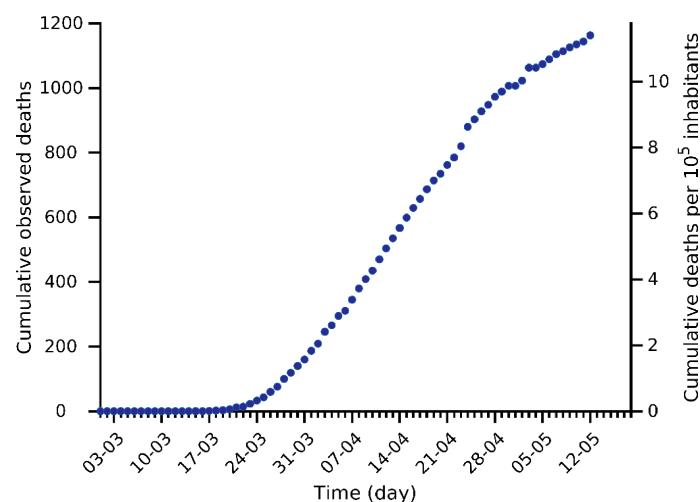
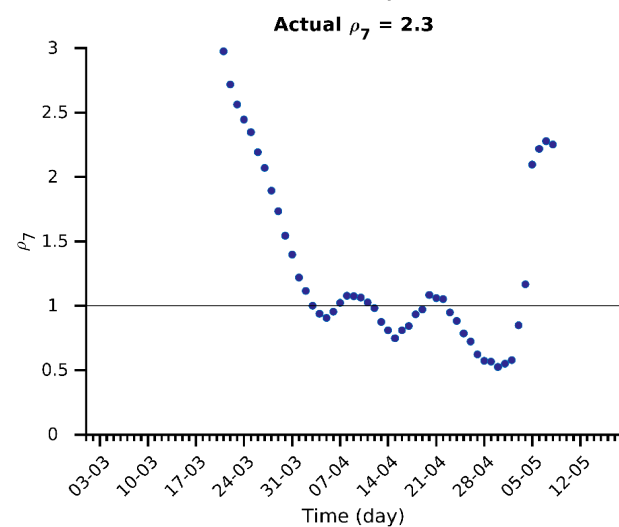
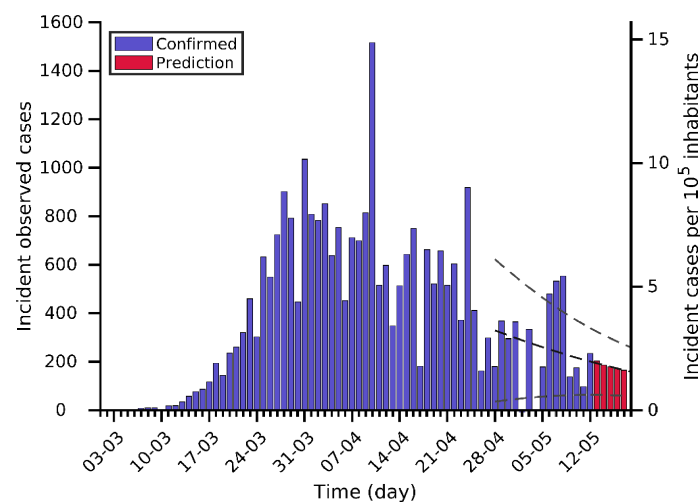
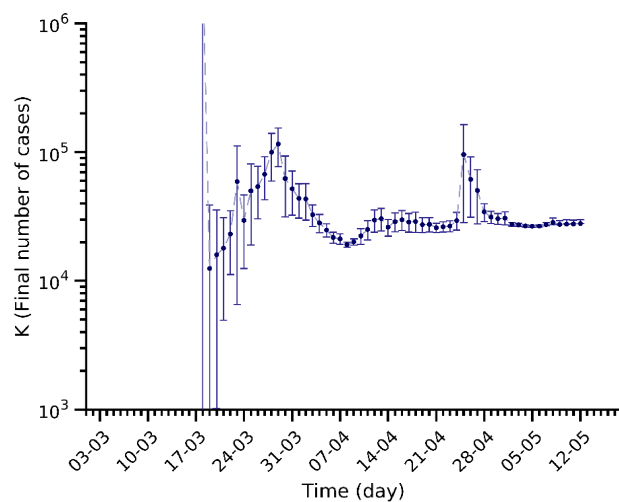
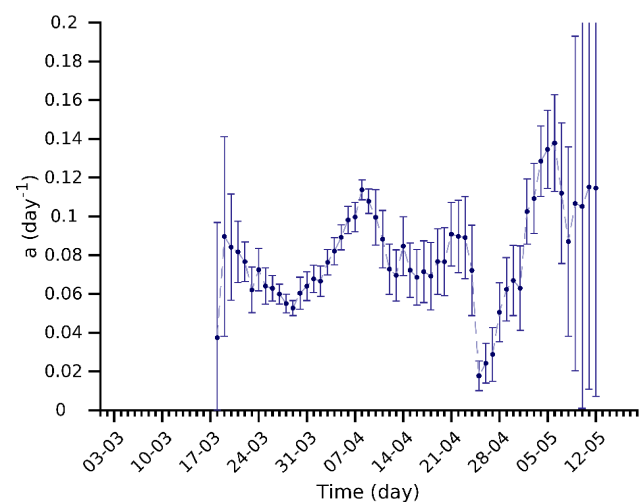
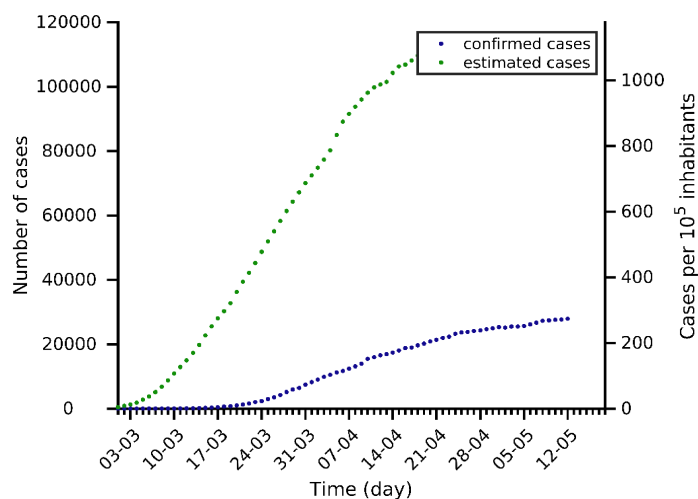
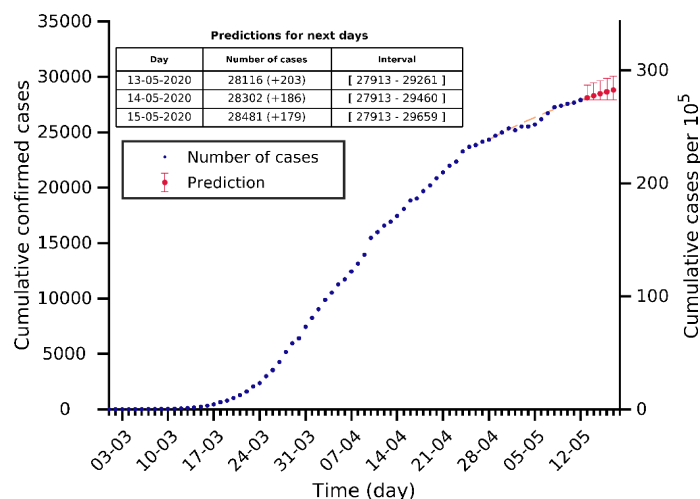
Netherlands 12-05-2020. Population: 17.1M. Current cumulated incidence: 251/10⁵



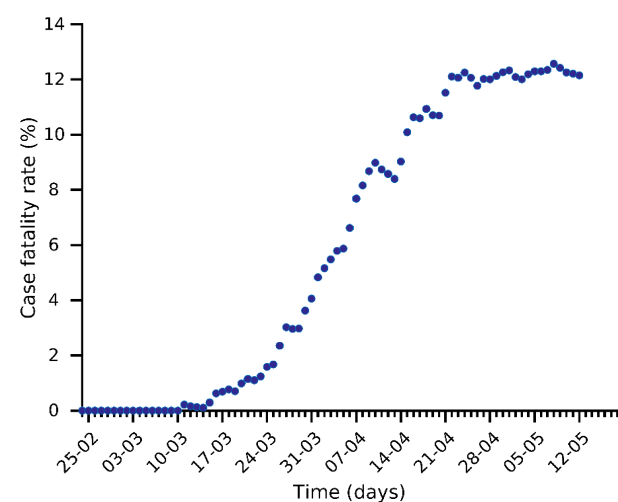
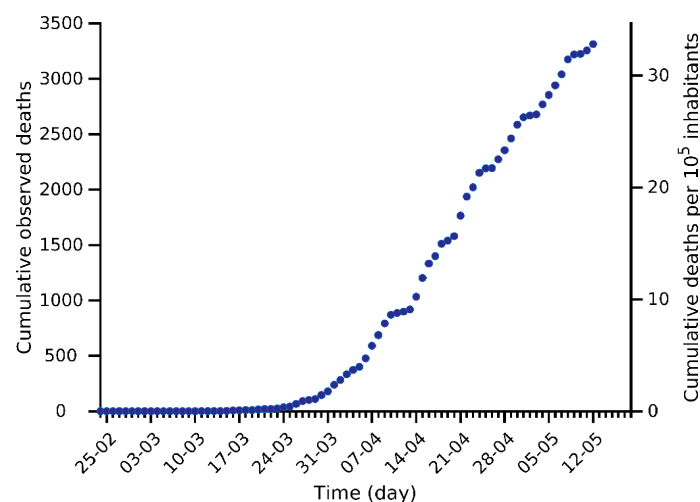
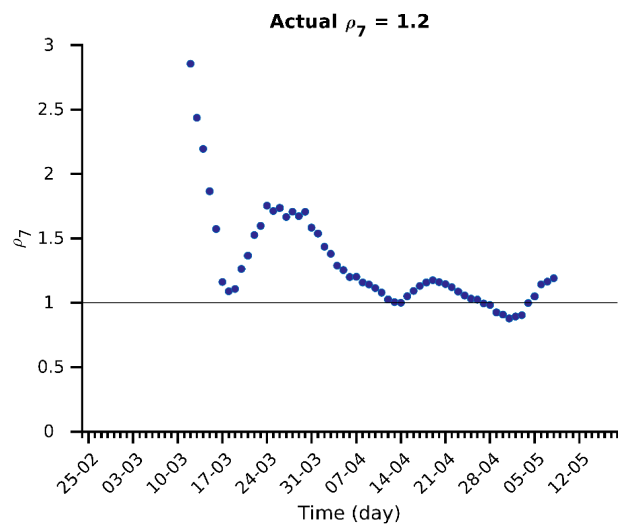
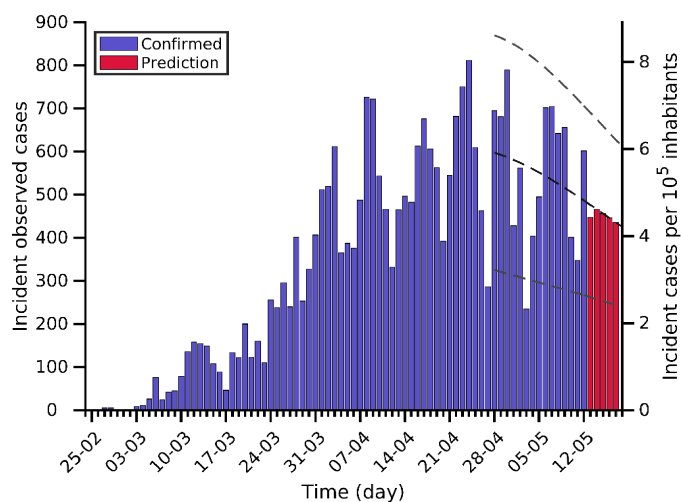
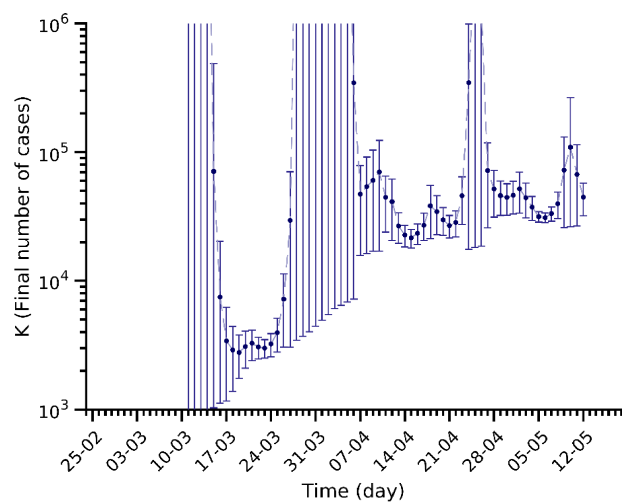
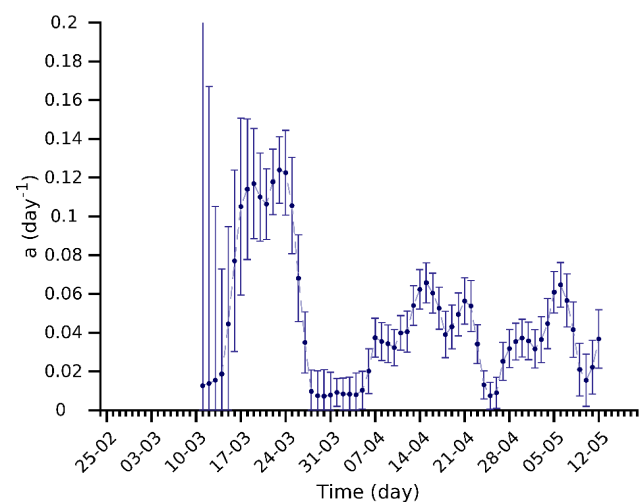
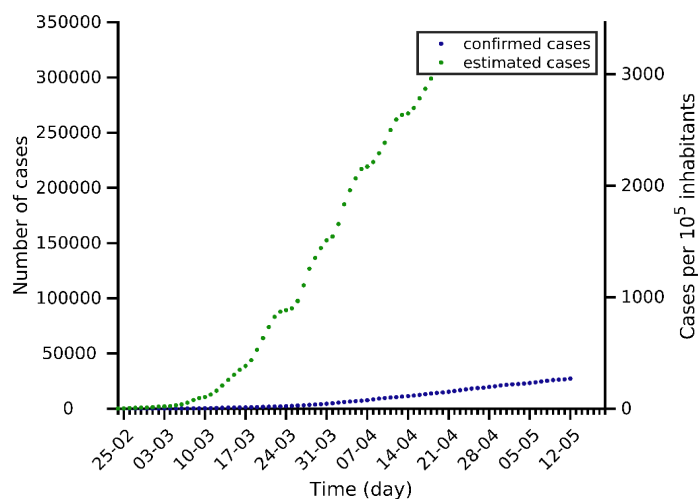
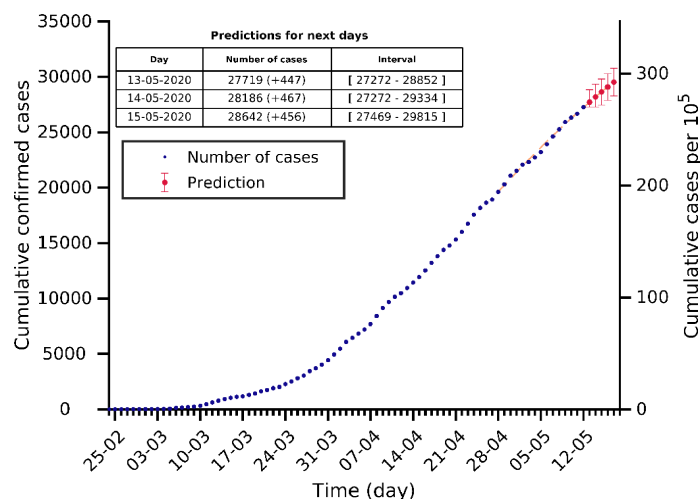
Switzerland 12-05-2020. Population: 8.7M. Current cumulated incidence: 350/10⁵



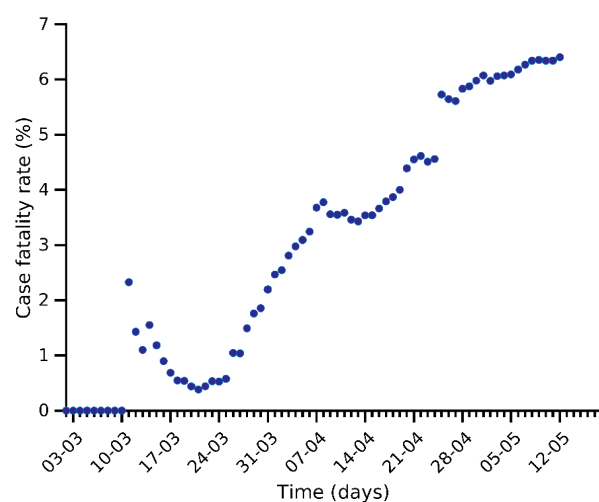
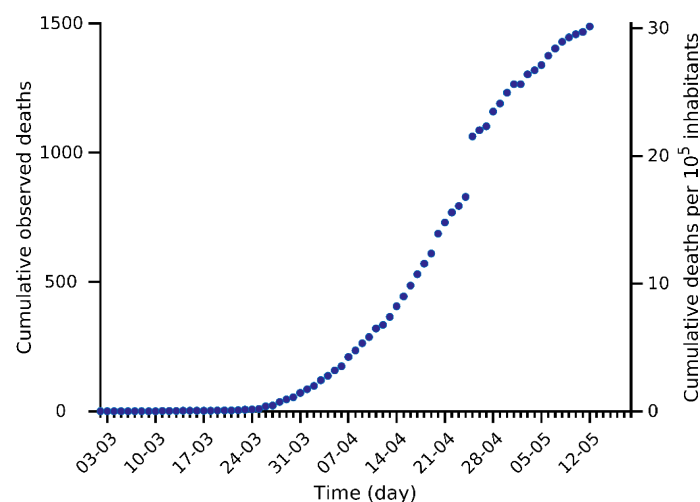
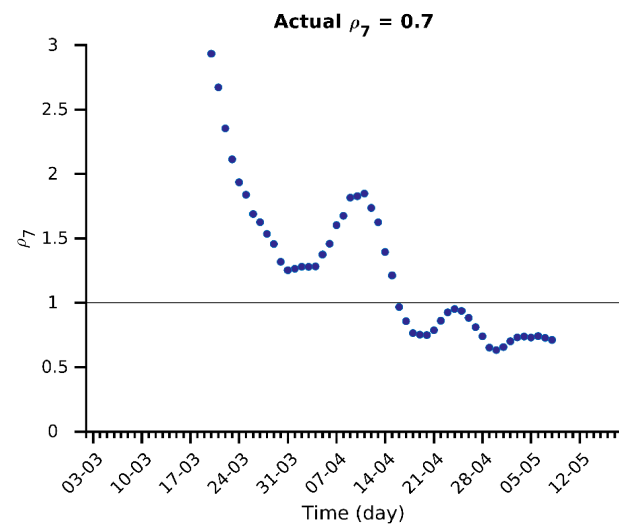
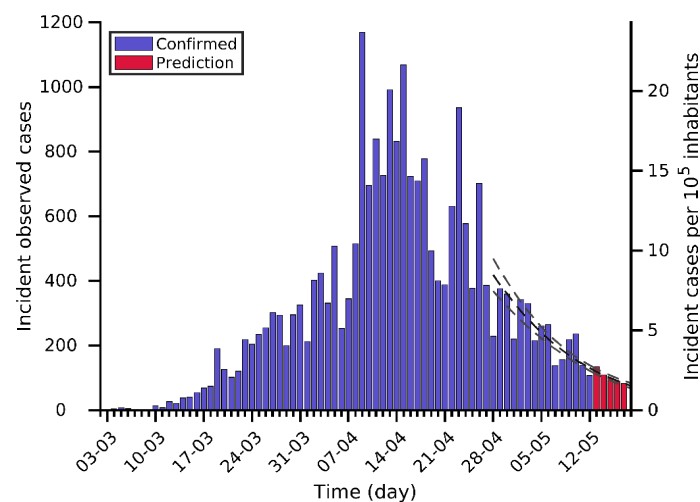
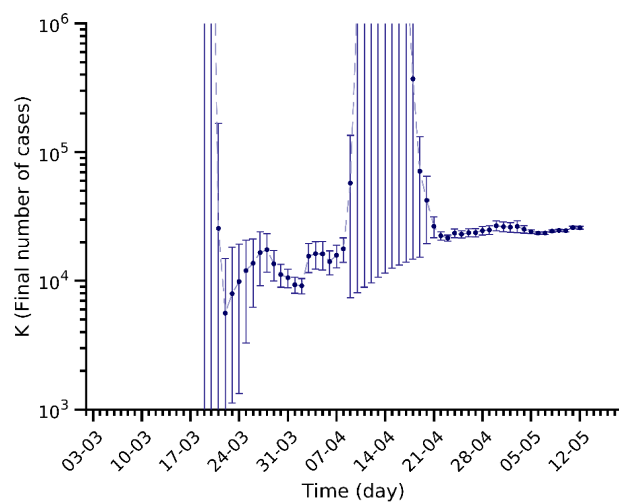
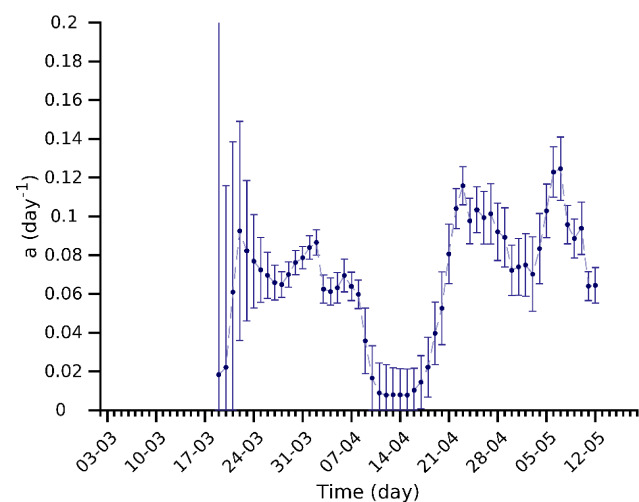
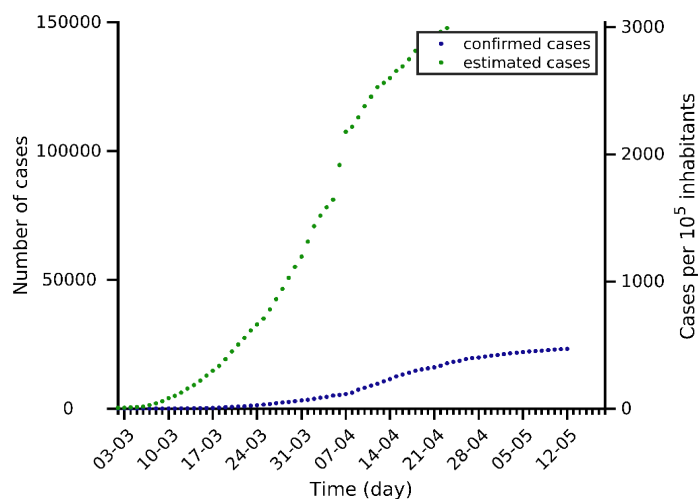
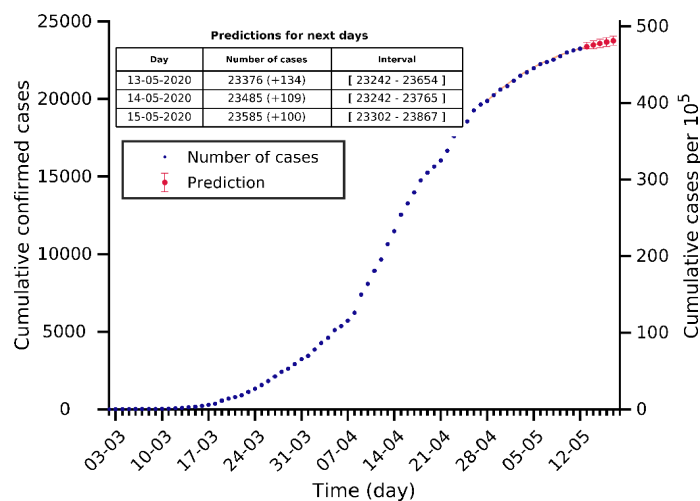
Portugal 12-05-2020. Population: 10.2M. Current cumulated incidence: 274/10⁵



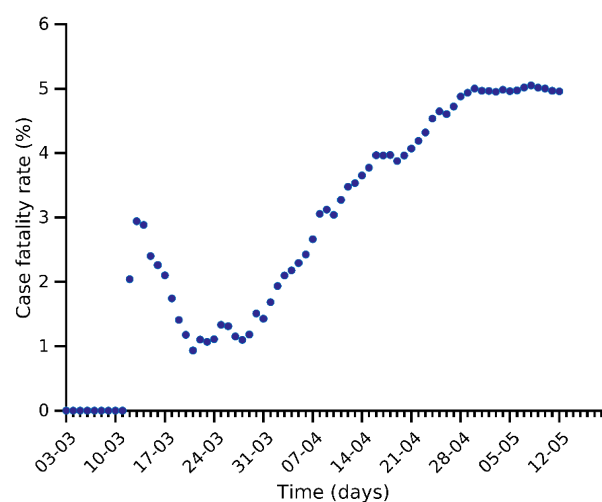
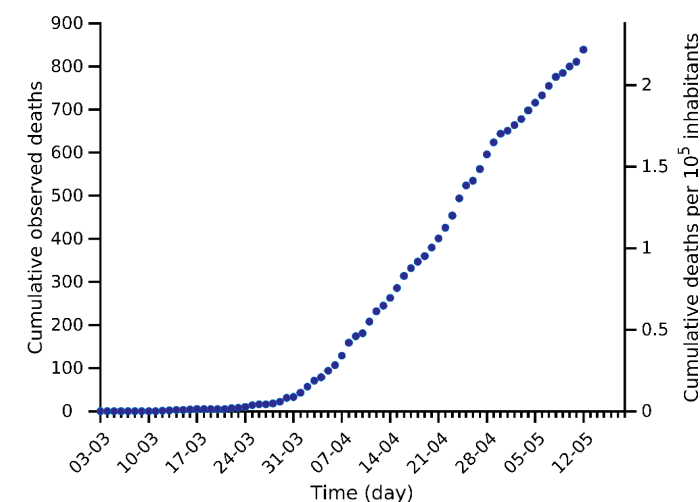
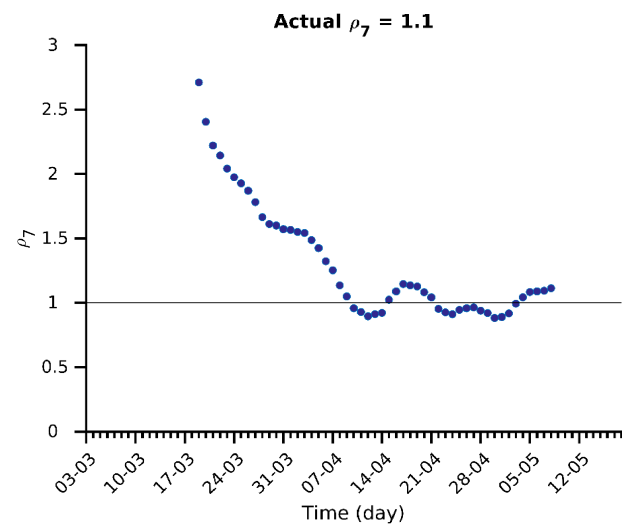
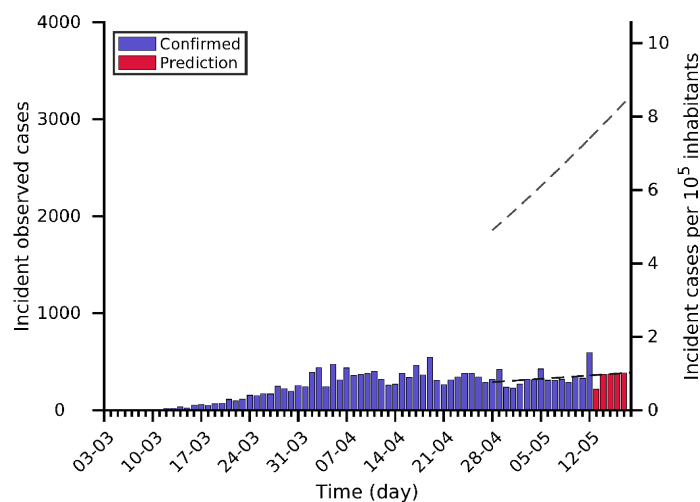
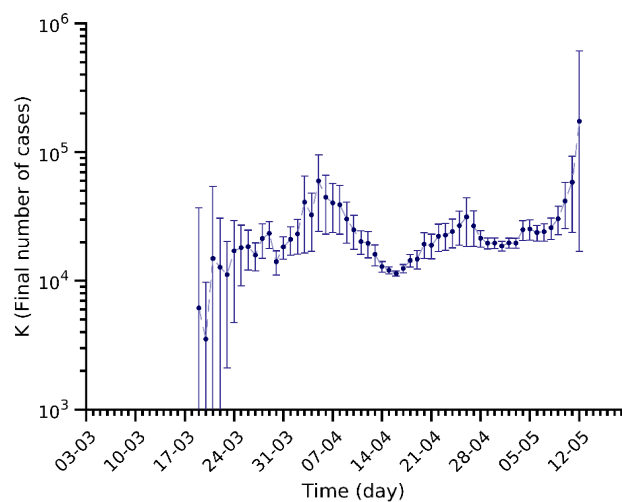
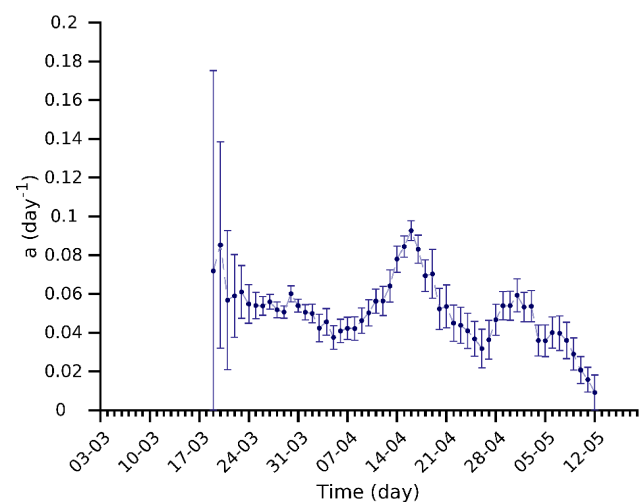
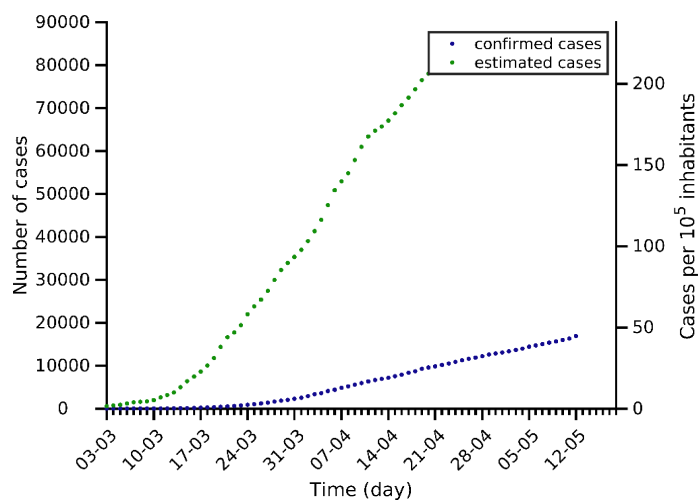
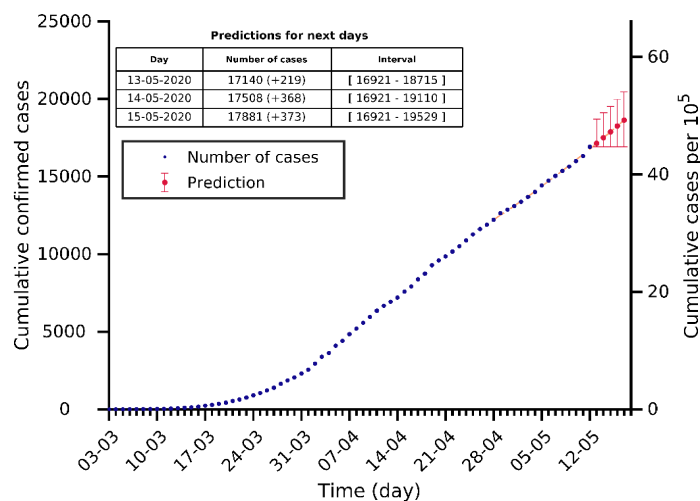
Sweden 12-05-2020. Population: 10.1M. Current cumulated incidence: 270/10⁵



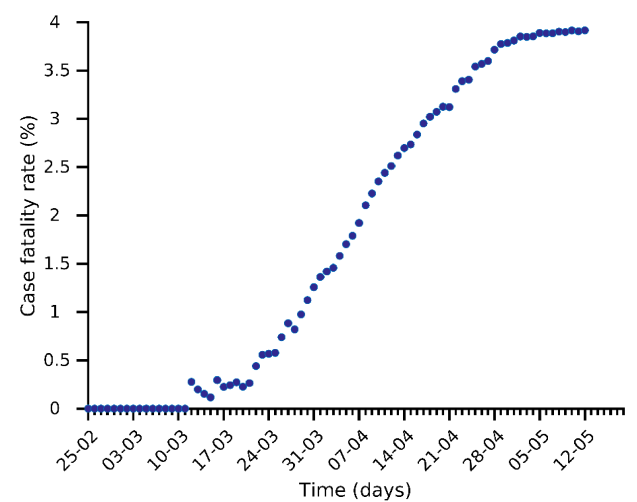
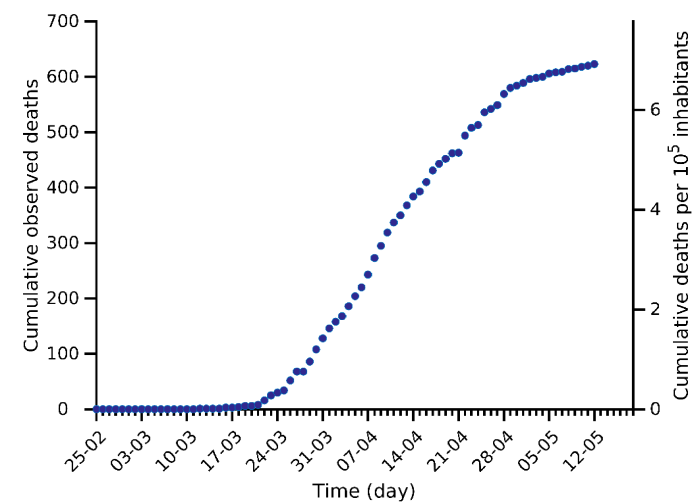
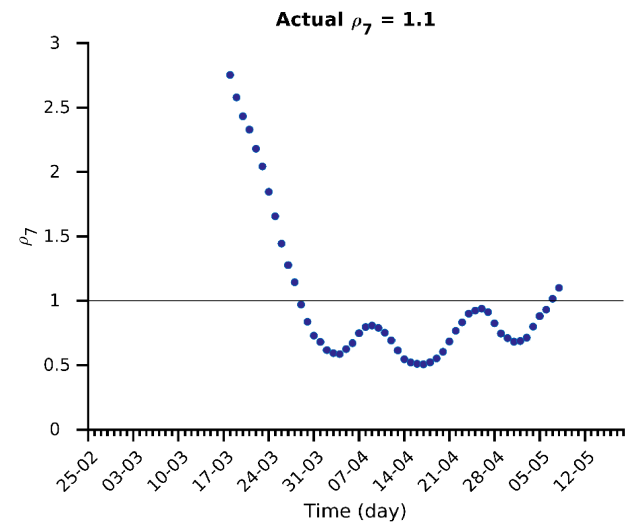
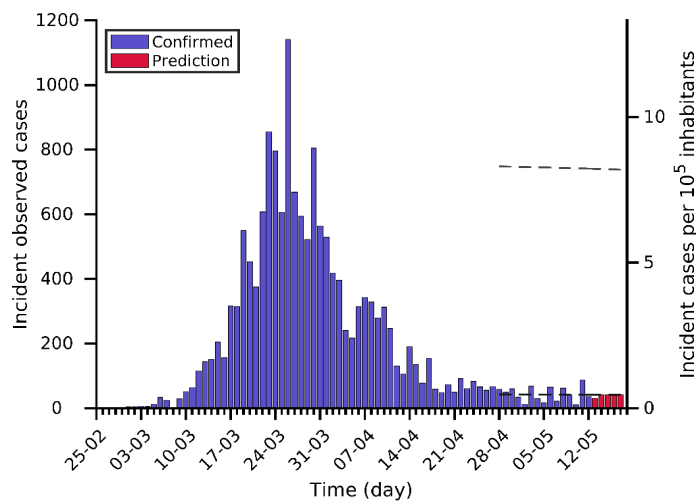
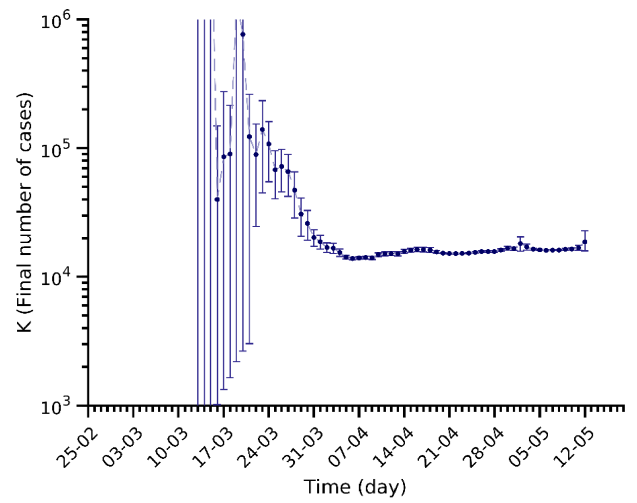
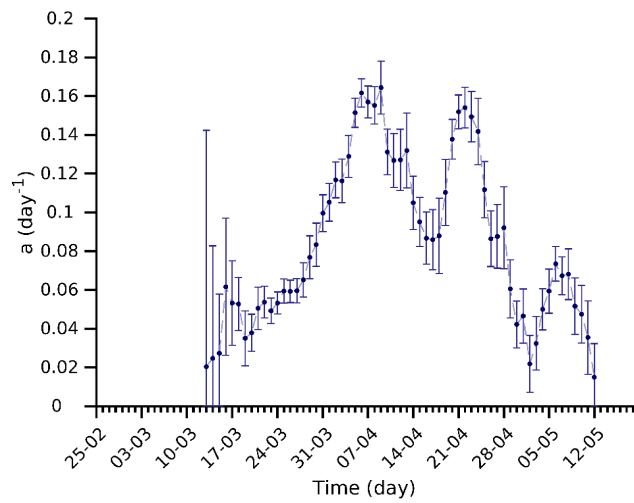
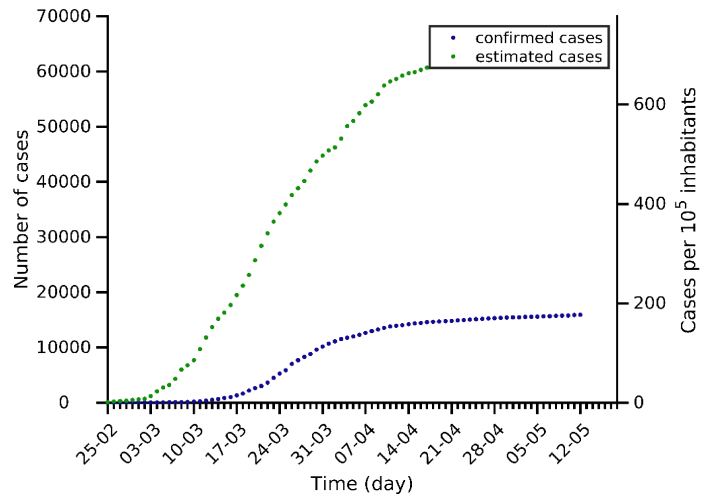
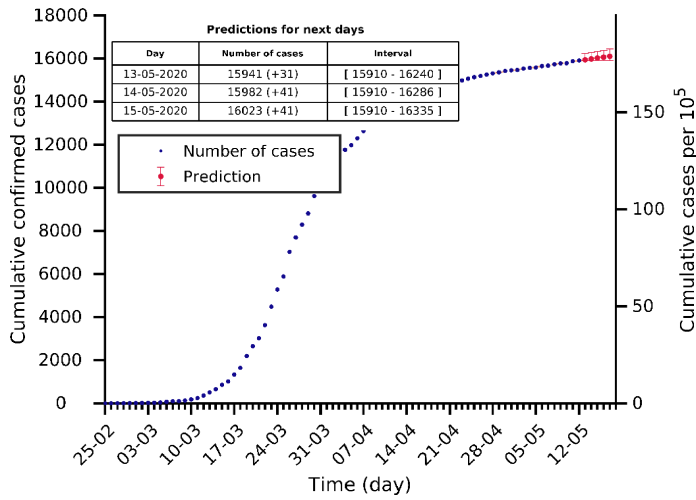
Ireland 12-05-2020. Population: 4.9M. Current cumulated incidence: 471/10⁵



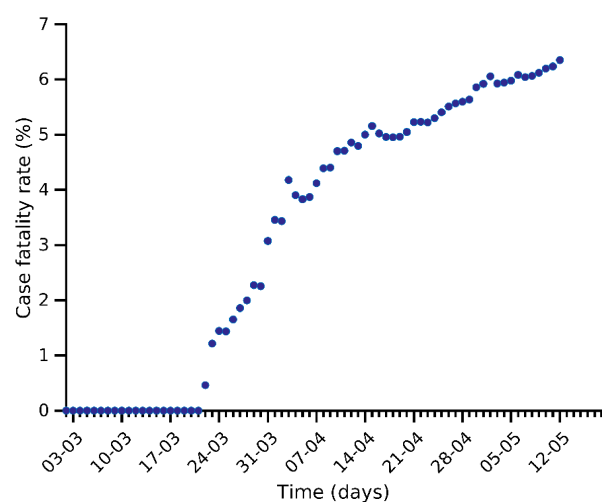
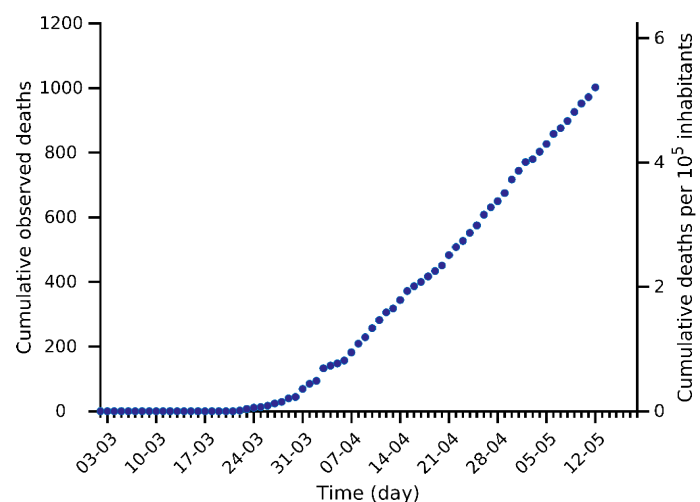
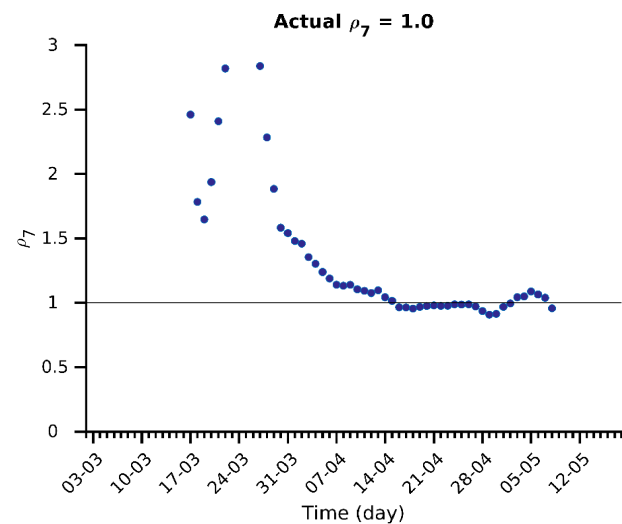
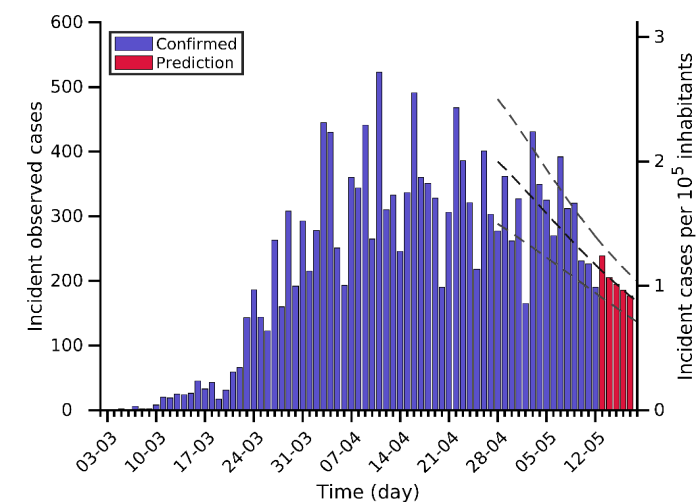
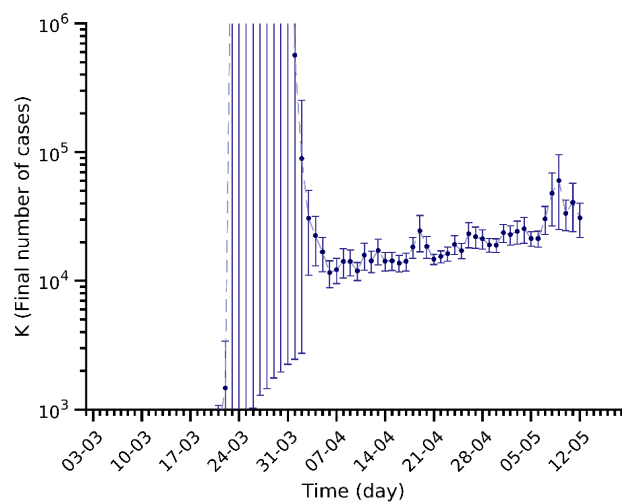
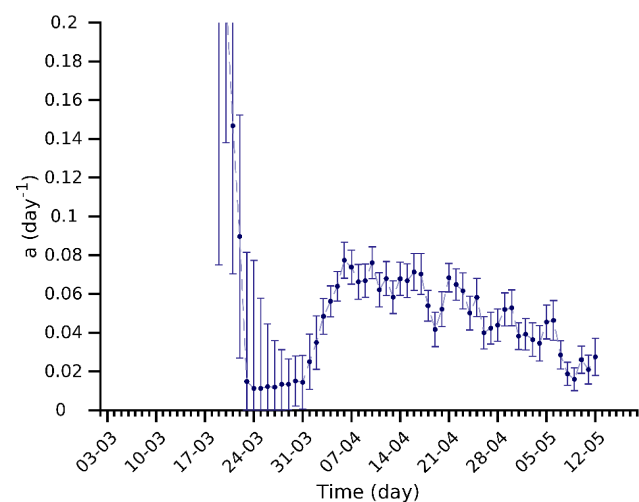
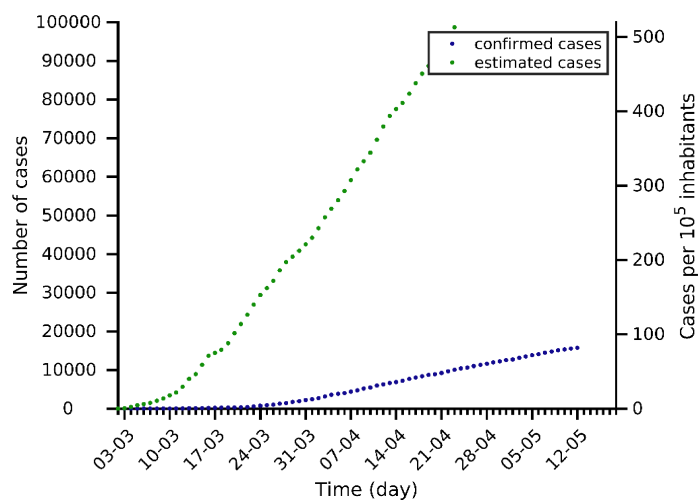
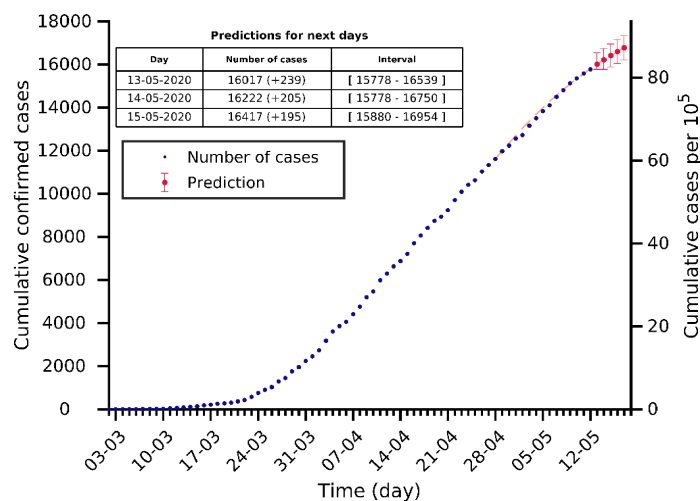
Poland 12-05-2020. Population: 37.8M. Current cumulated incidence: 45/10⁵



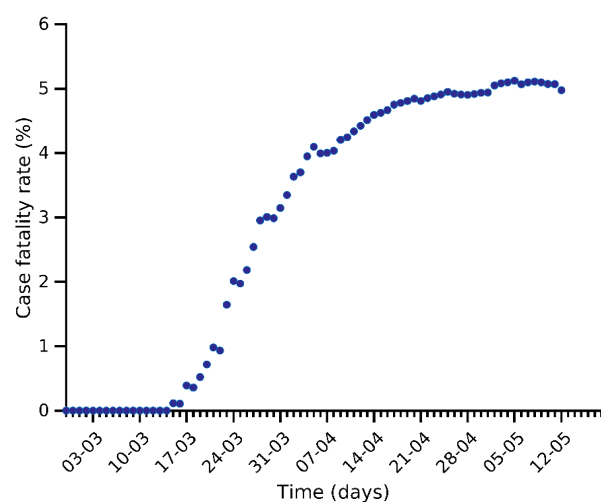
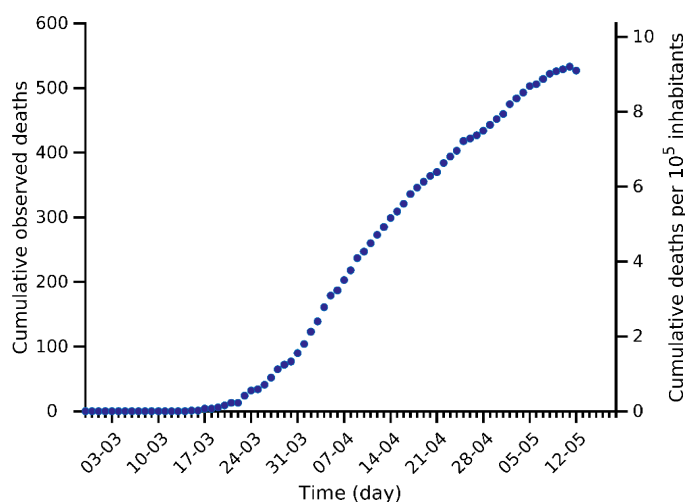
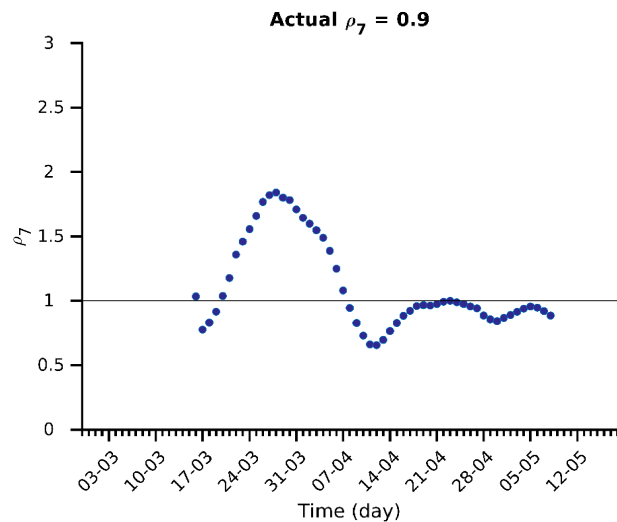
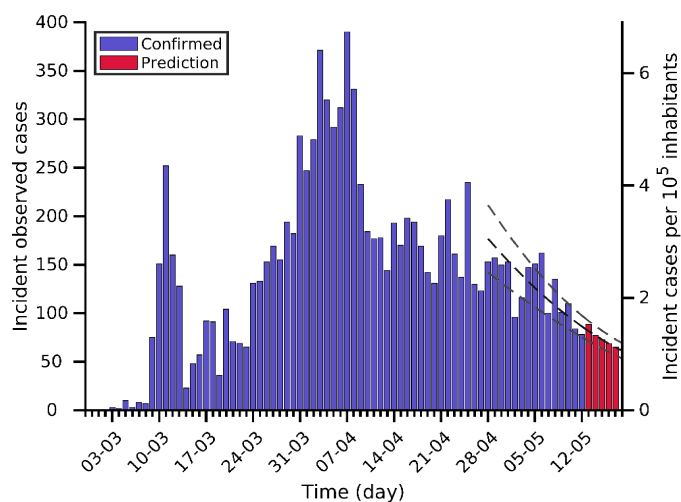
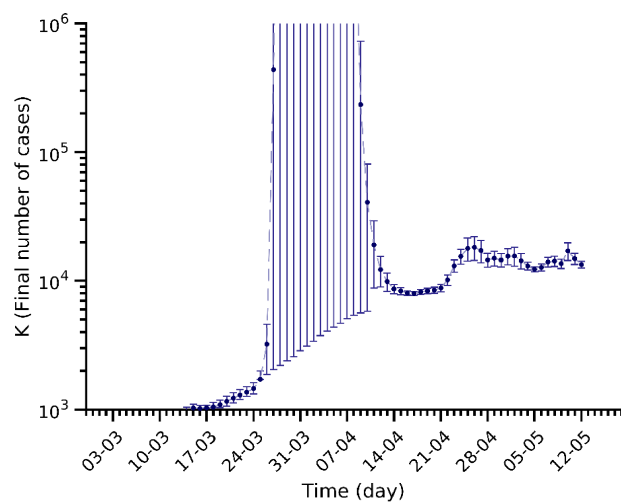
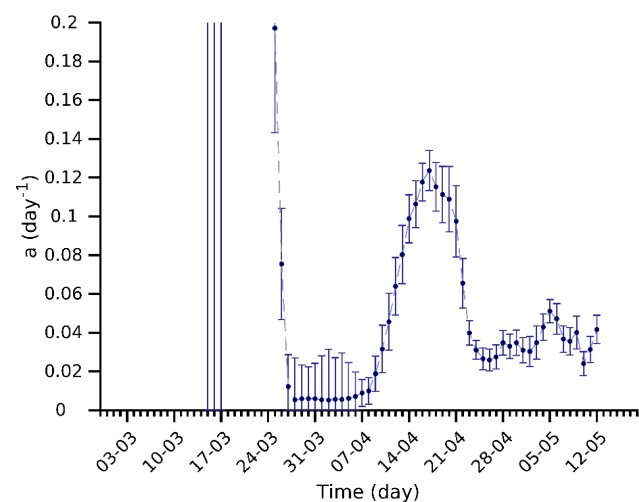
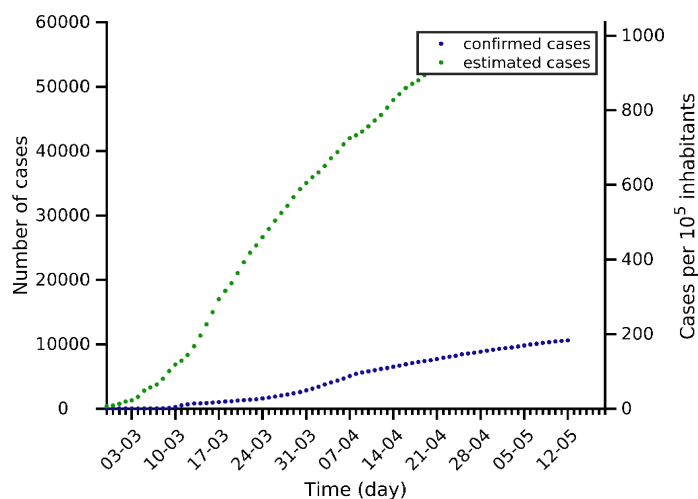
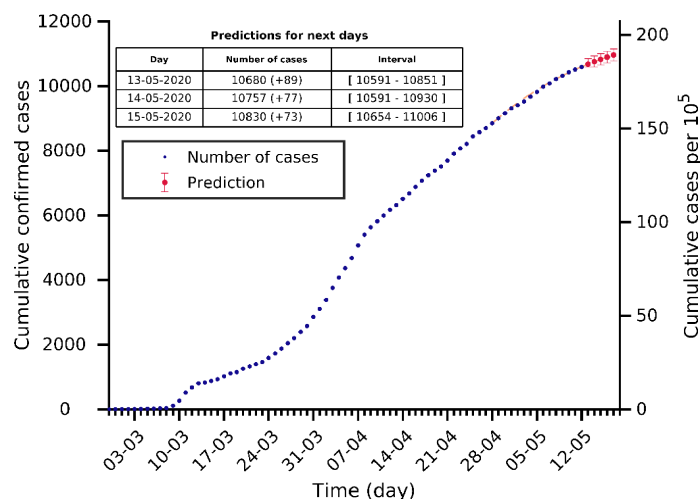
Austria 12-05-2020. Population: 9.0M. Current cumulated incidence: 177/10⁵



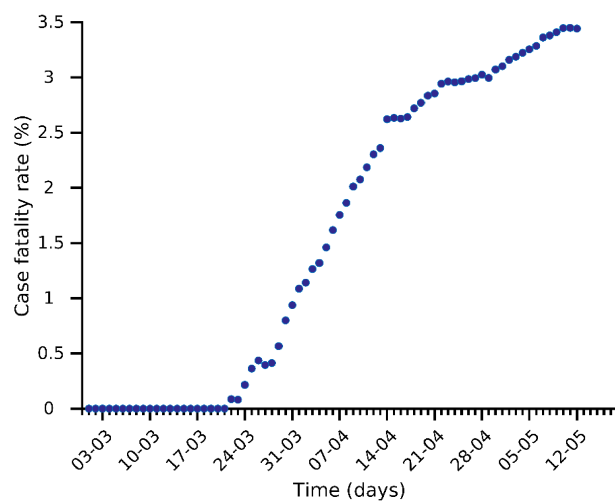
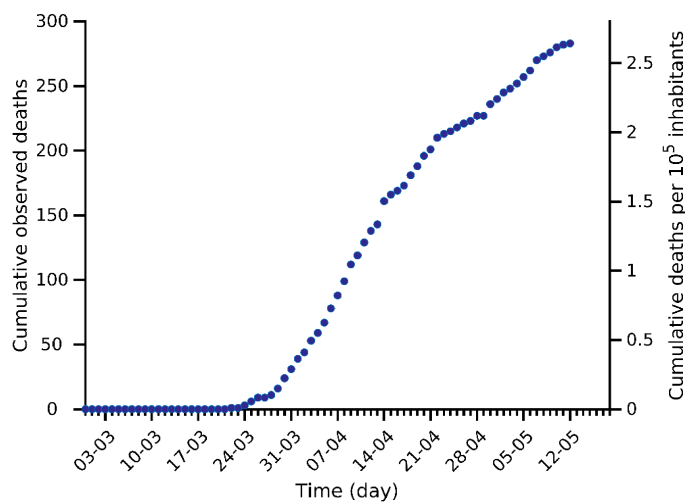
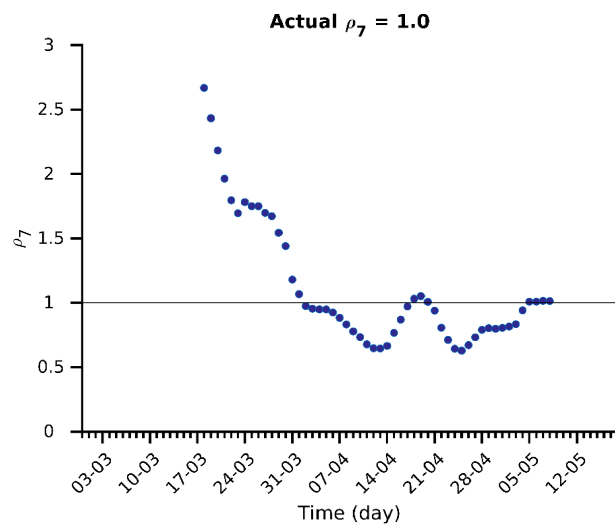
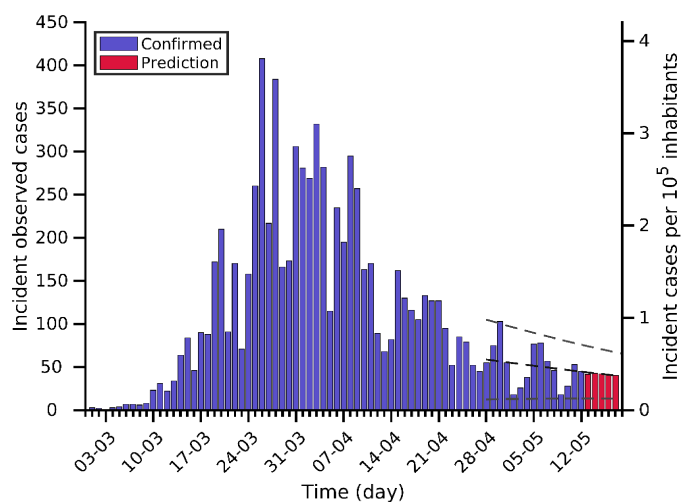
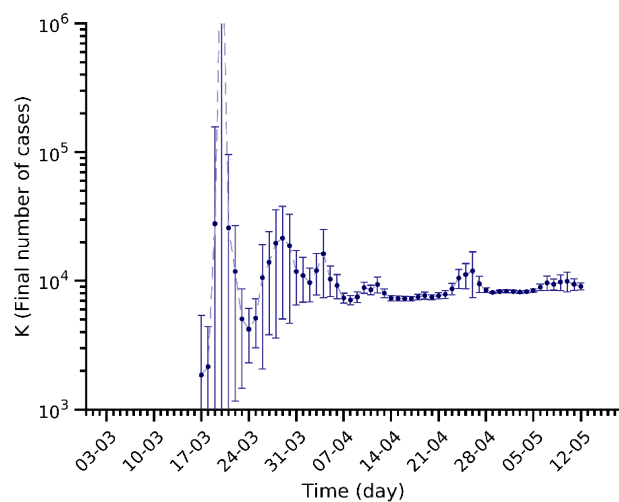
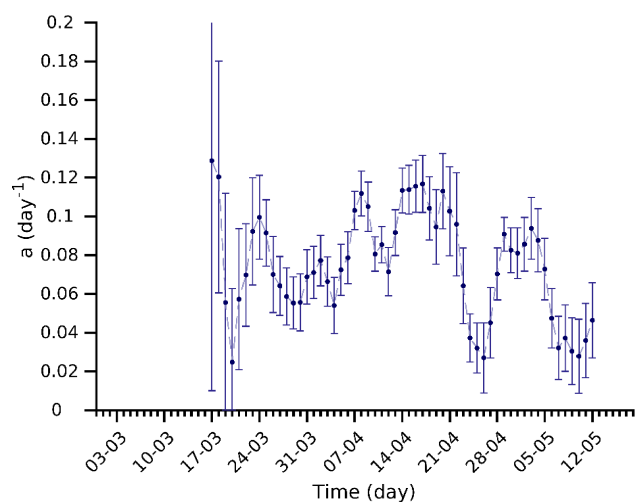
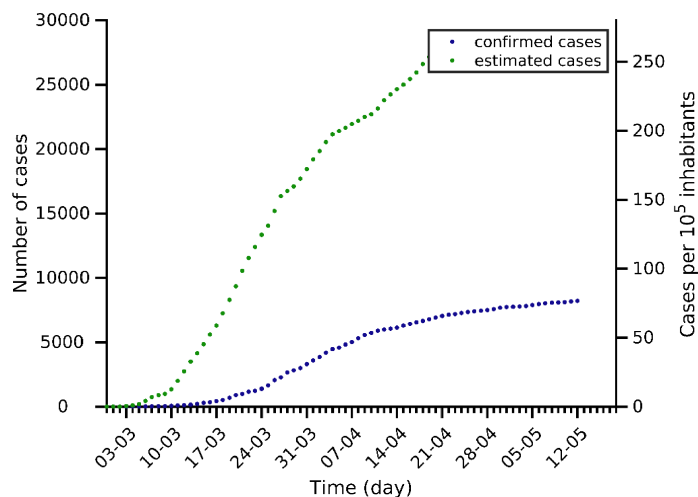
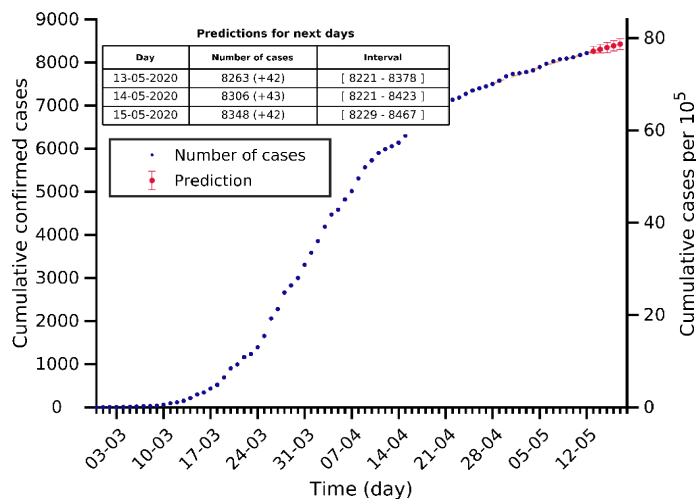
Romania 12-05-2020. Population: 19.2M. Current cumulated incidence: 82/10⁵



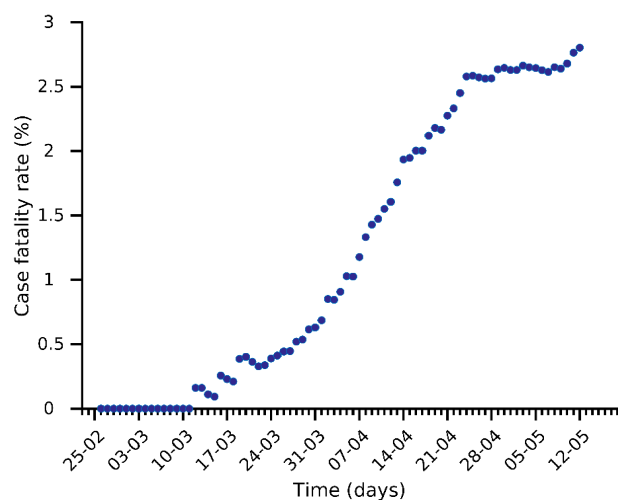
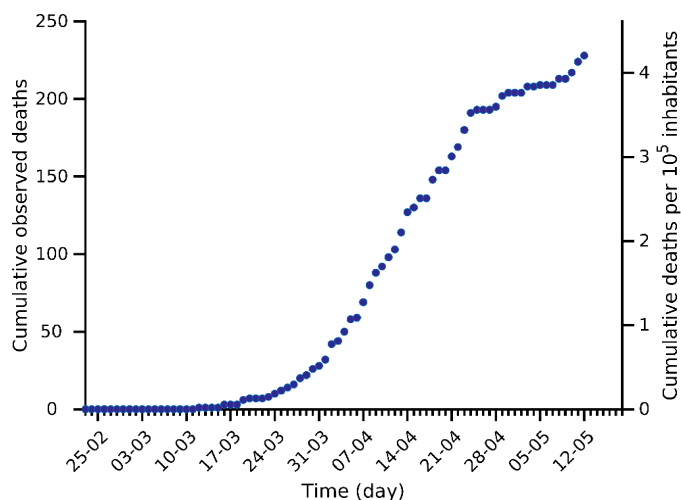
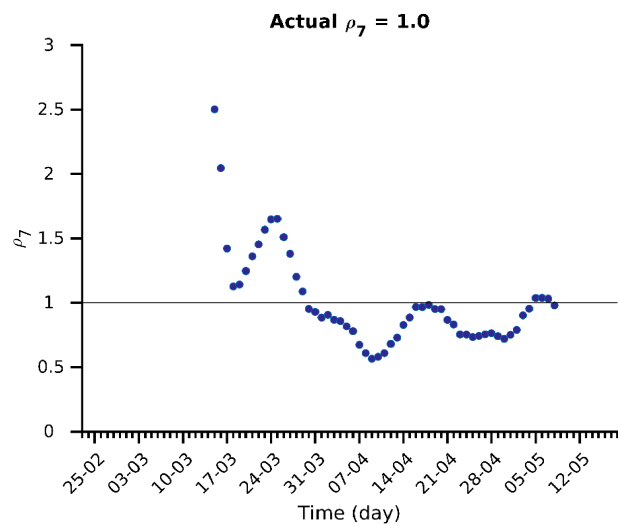
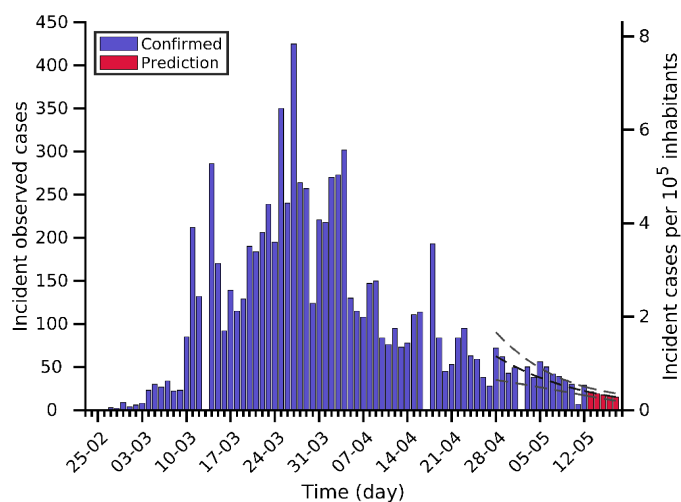
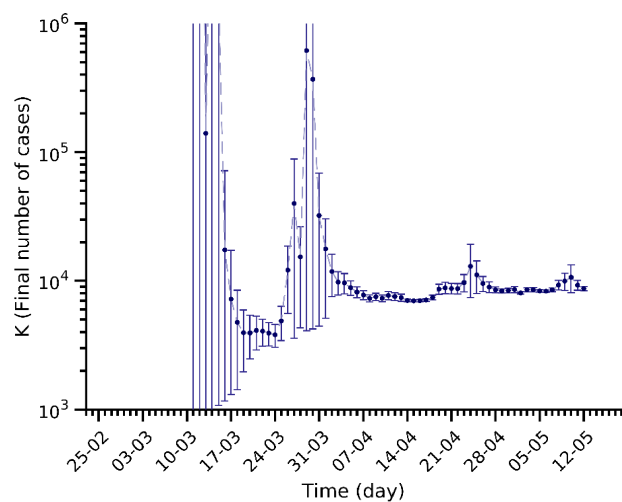
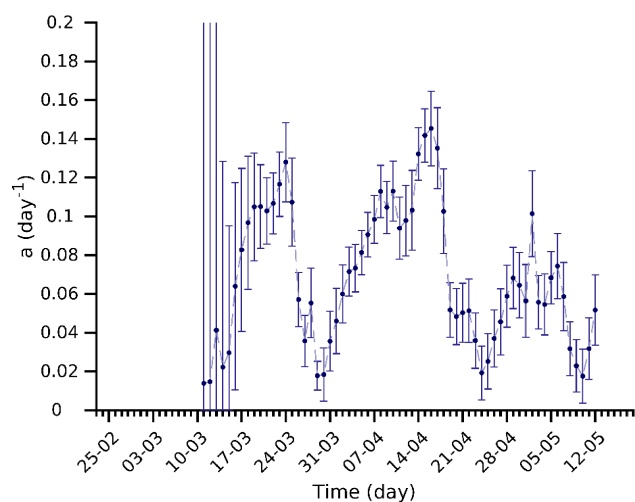
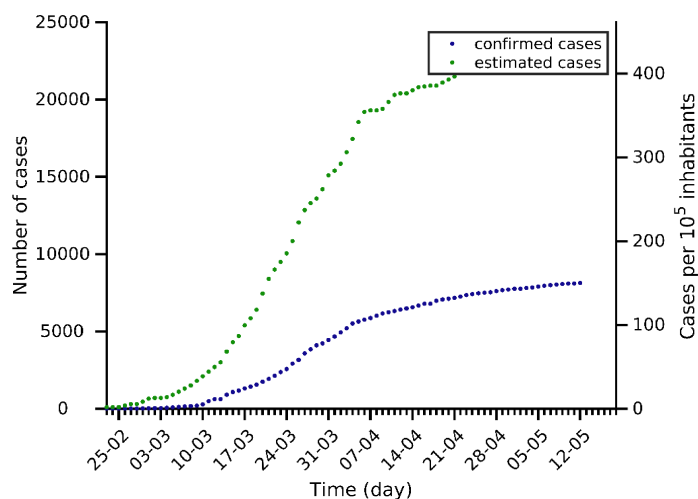
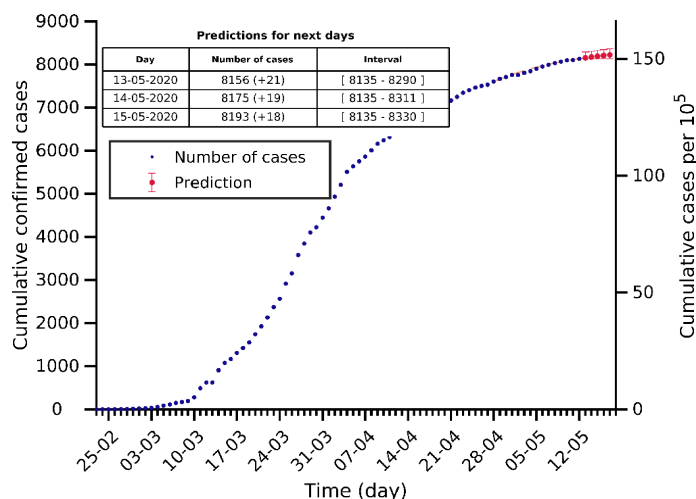
Denmark 12-05-2020. Population: 5.8M. Current cumulated incidence: 183/10⁵



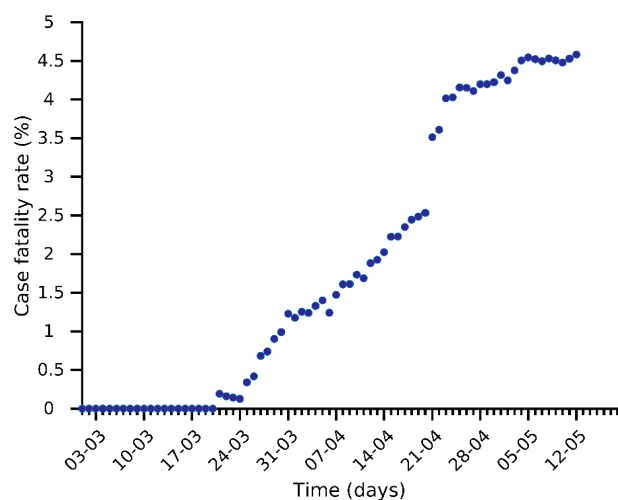
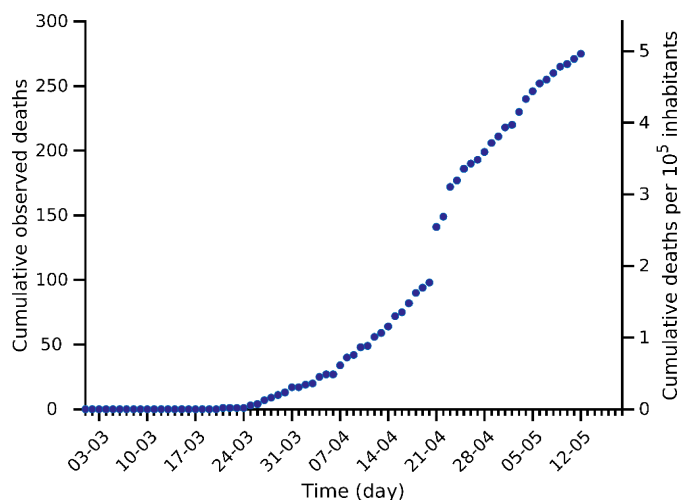
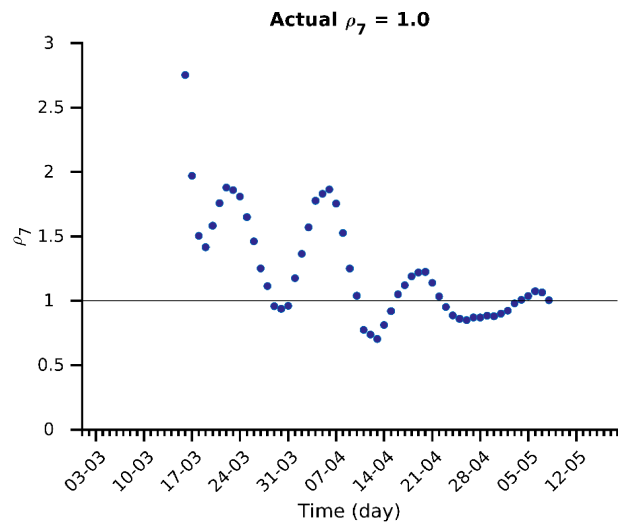
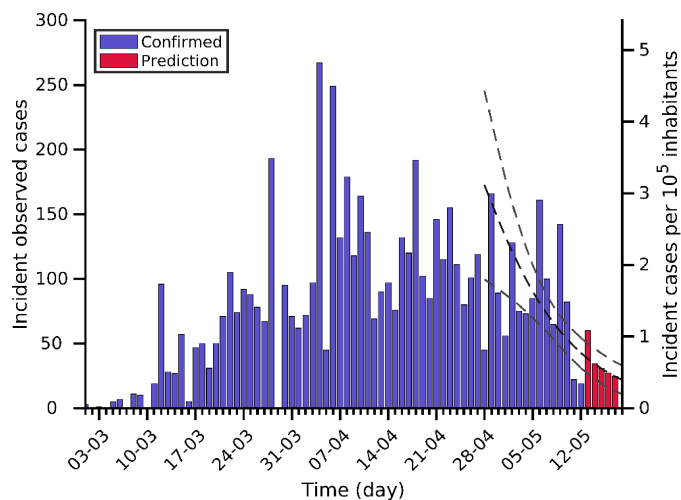
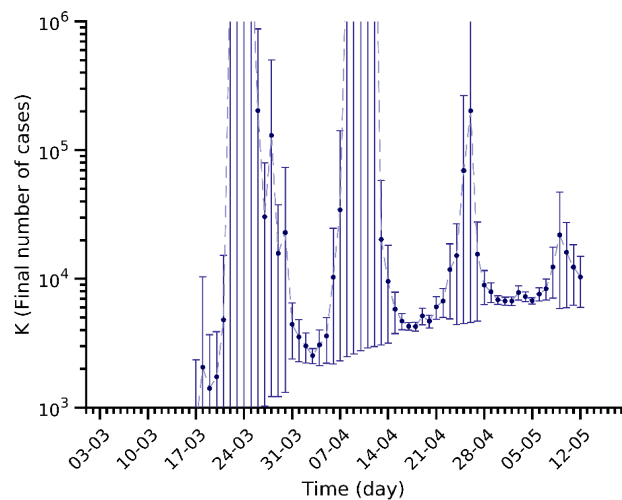
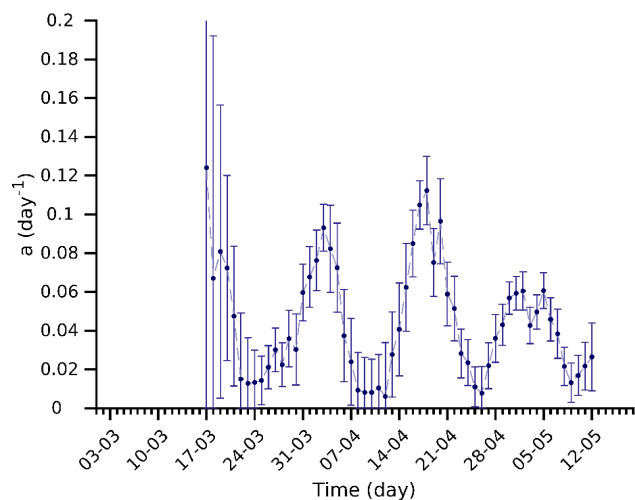
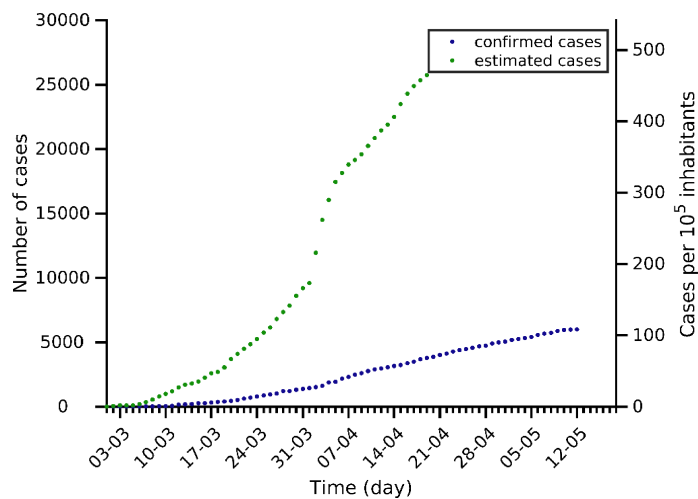
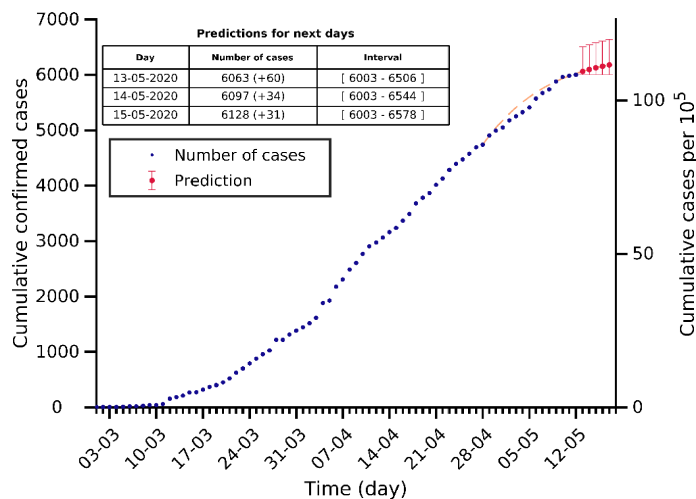
Czech Rep 12-05-2020. Population: 10.7M. Current cumulated incidence: 77/10⁵



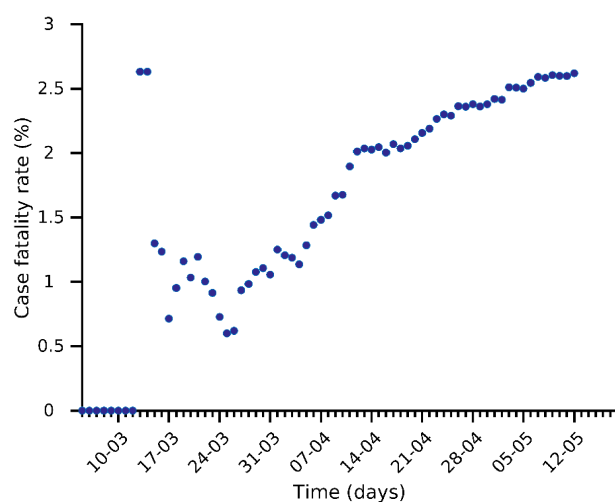
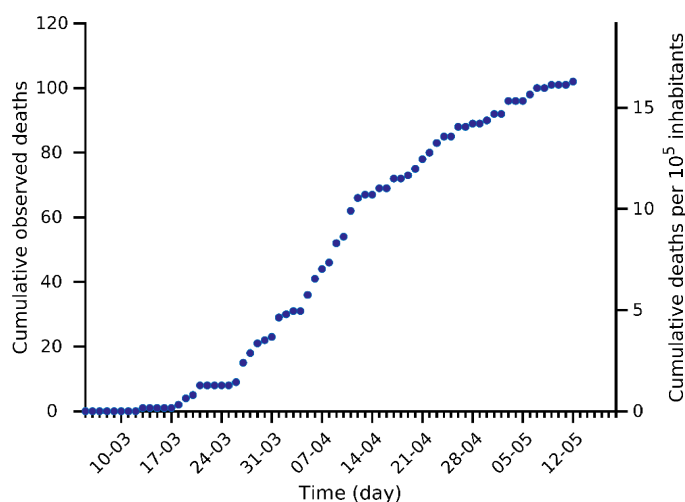
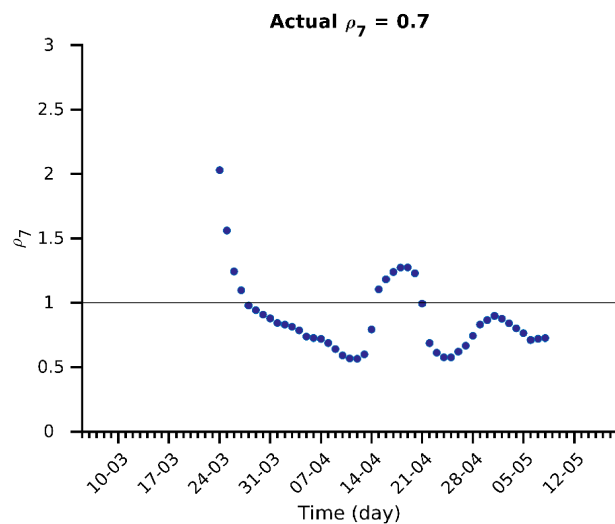
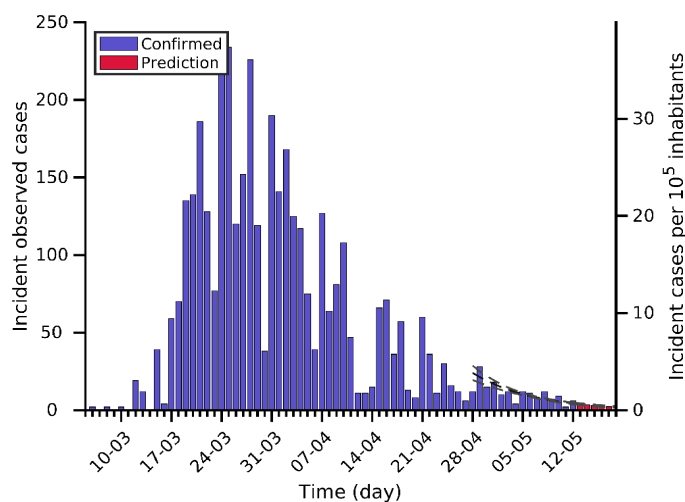
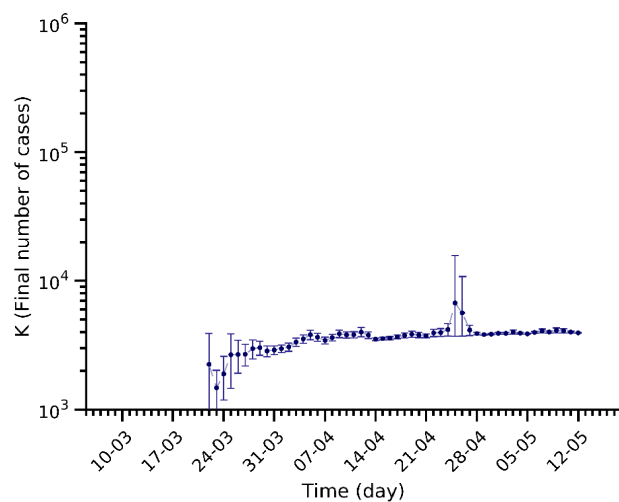
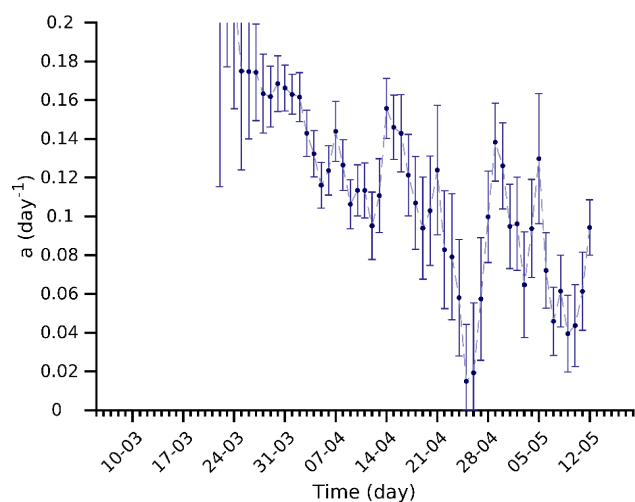
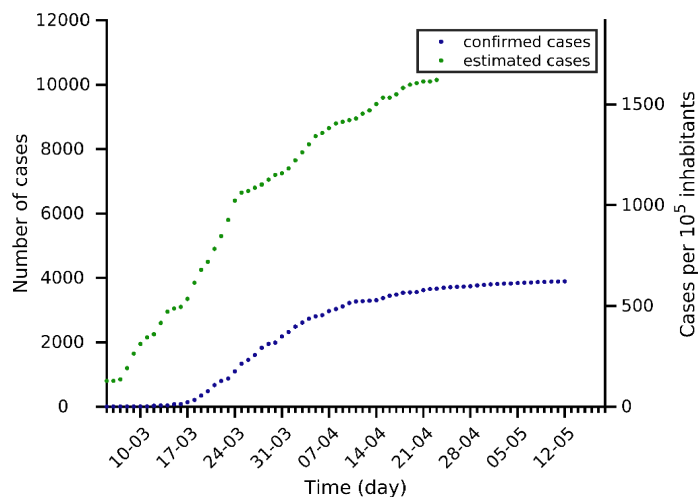
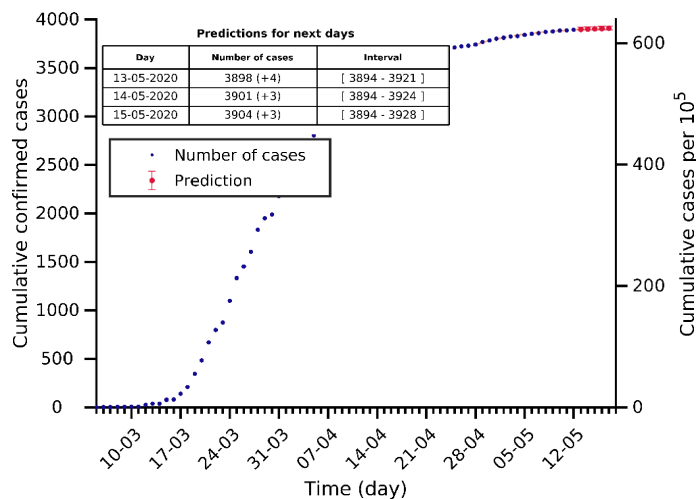
Norway 12-05-2020. Population: 5.4M. Current cumulated incidence: 150/10⁵



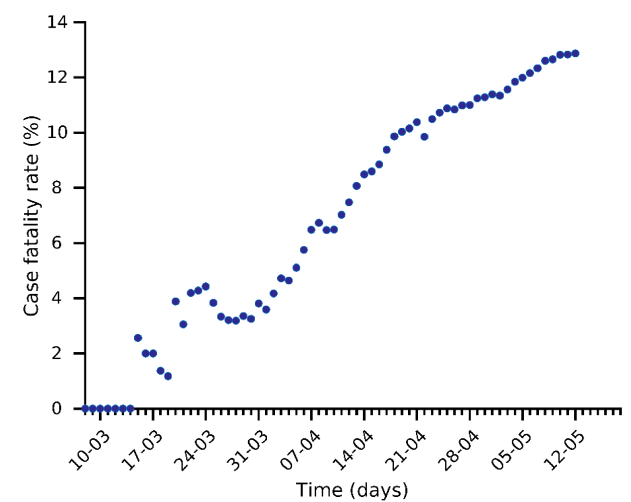
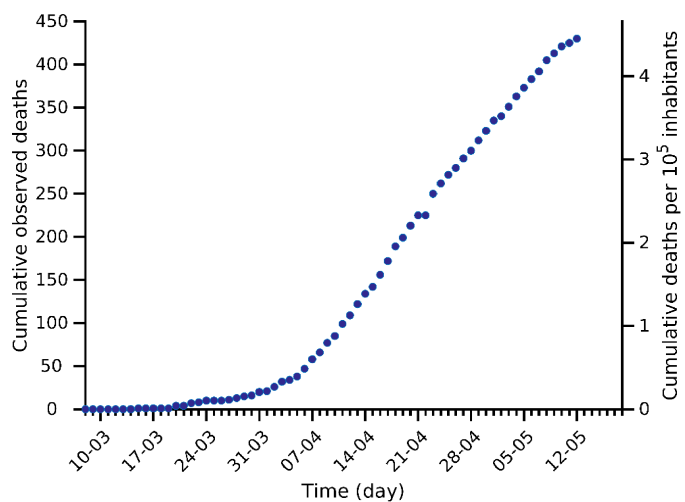
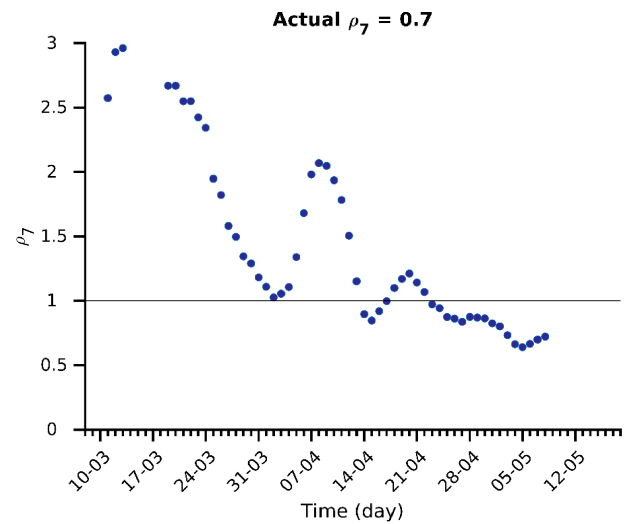
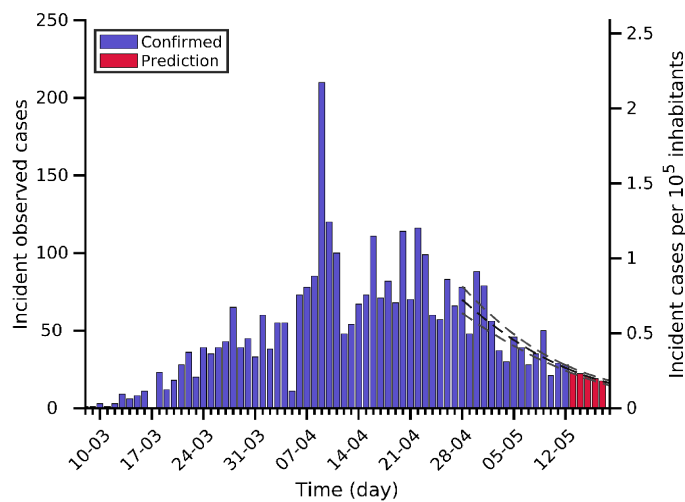
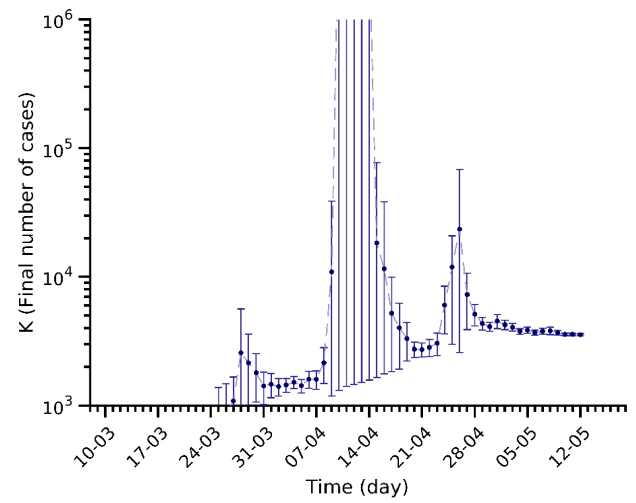
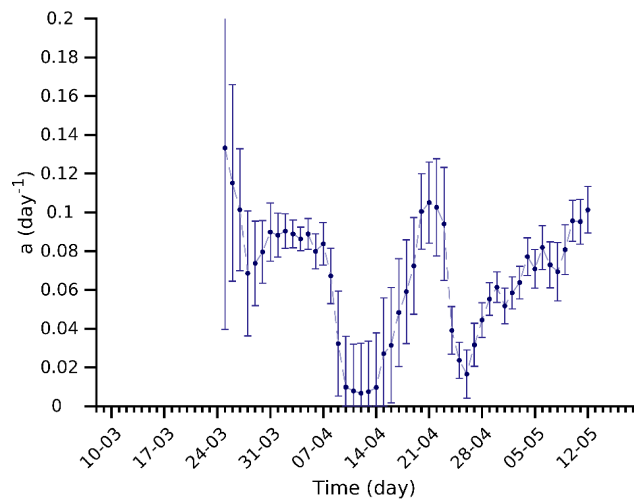
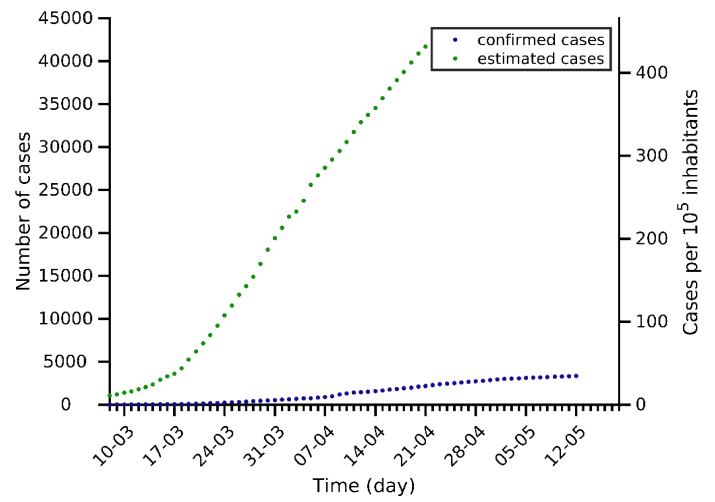
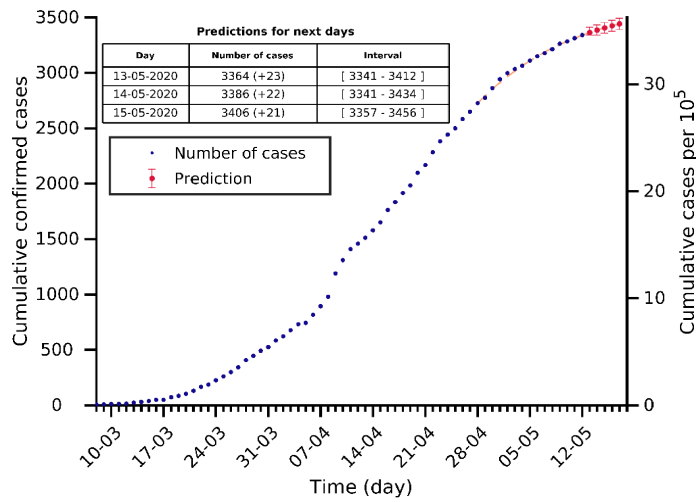
Finland 12-05-2020. Population: 5.5M. Current cumulated incidence: 108/10⁵



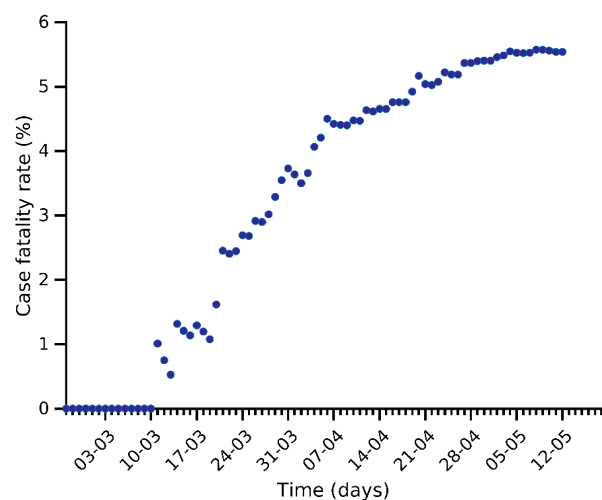
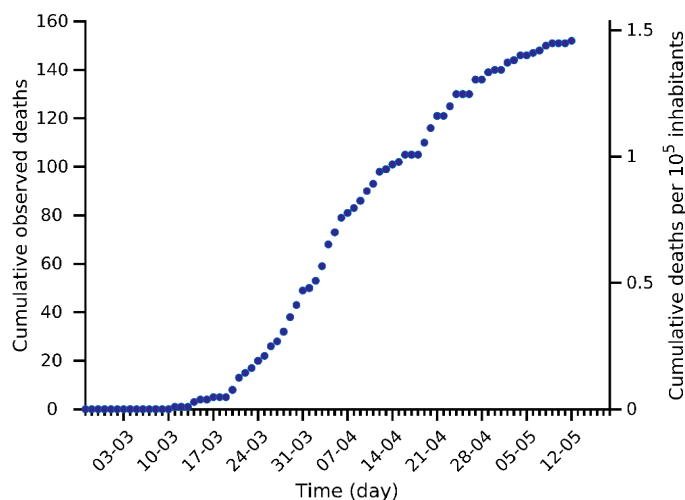
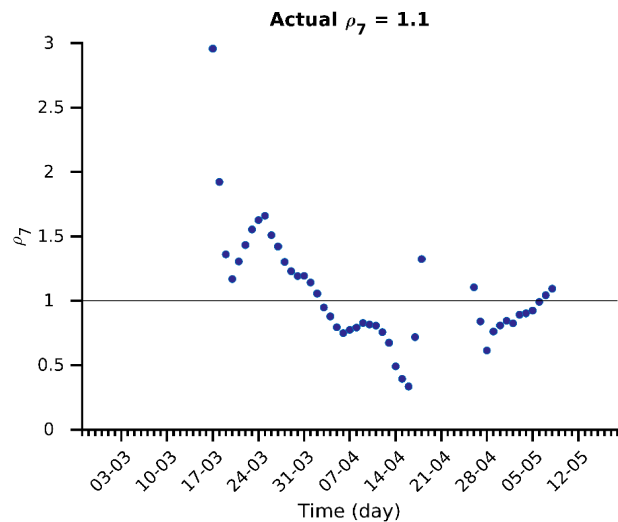
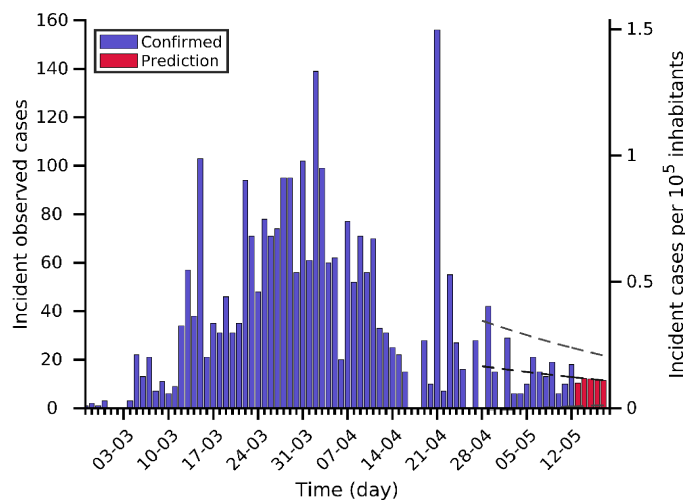
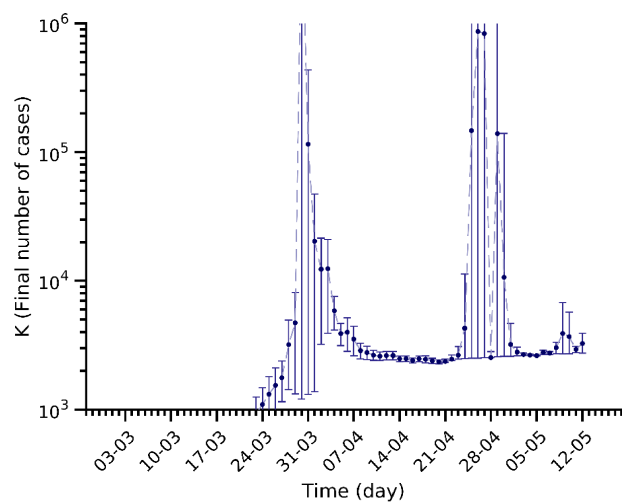
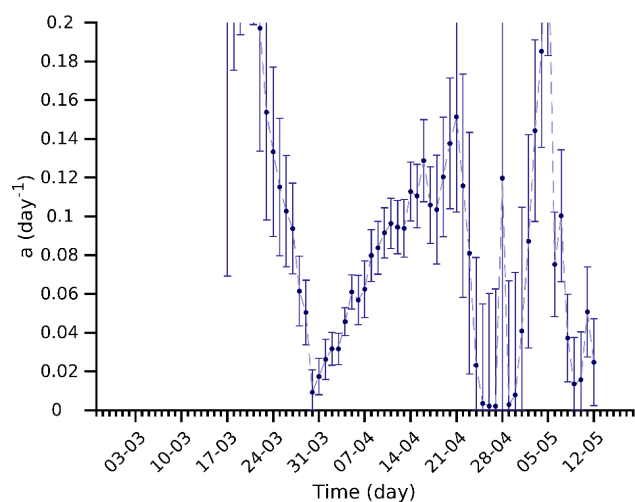
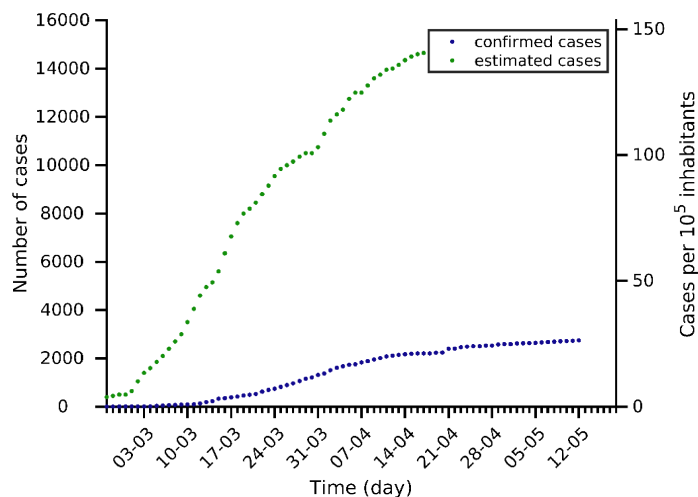
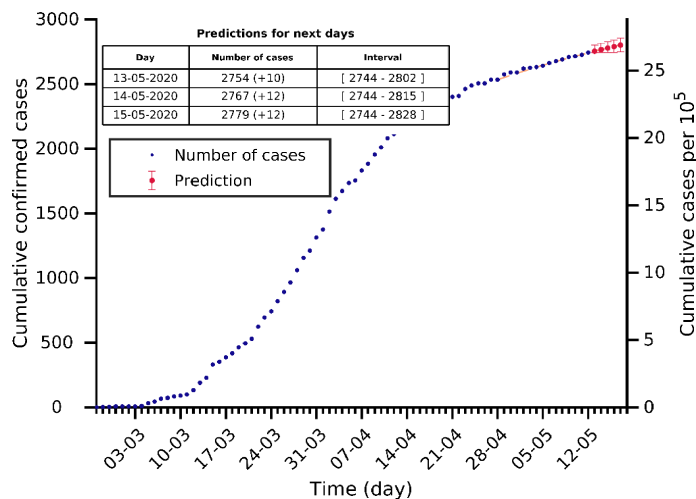
Luxembourg 12-05-2020. Population: 0.6M. Current cumulated incidence: 622/10⁵



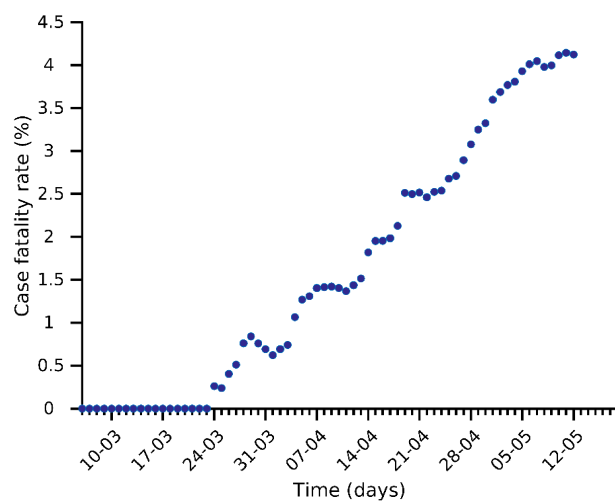
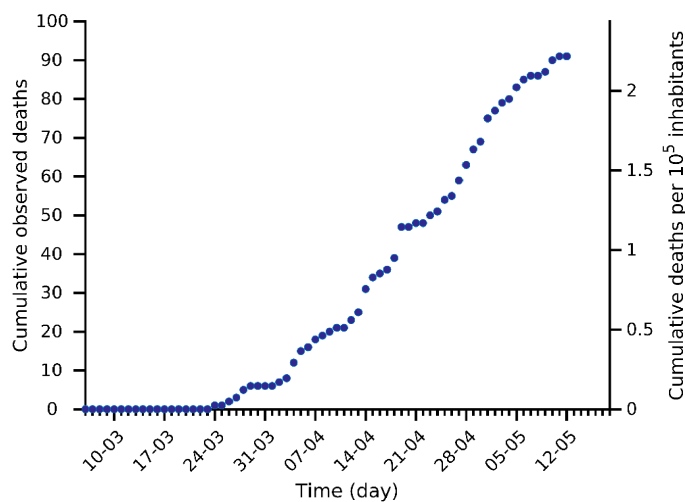
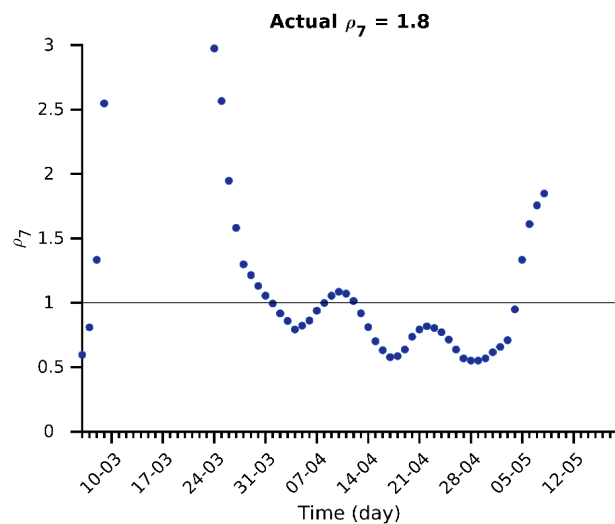
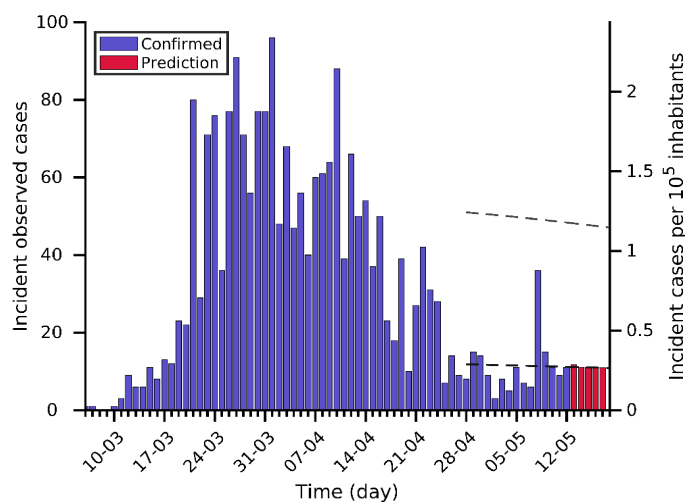
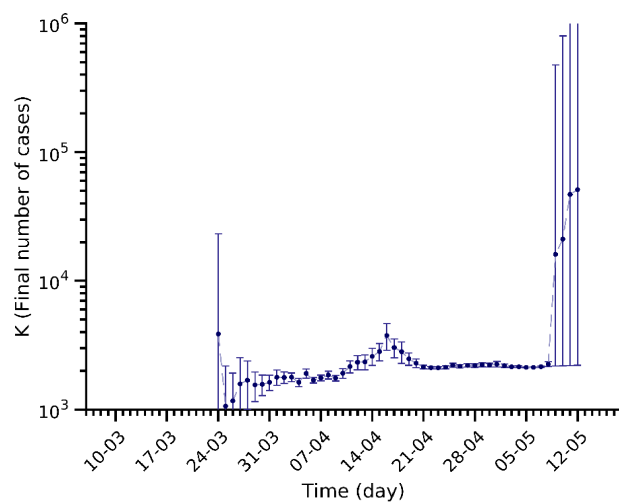
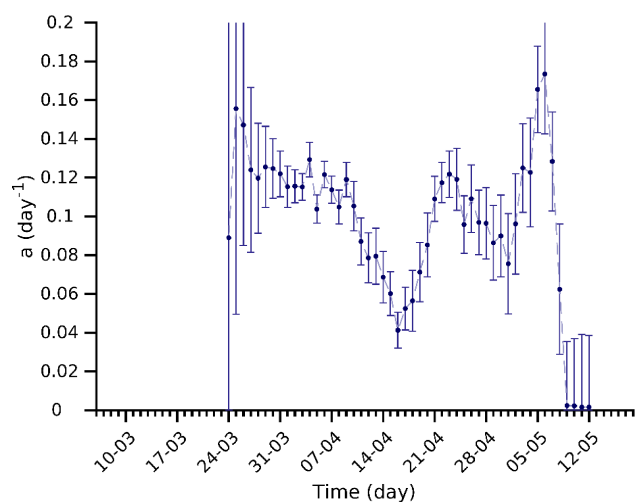
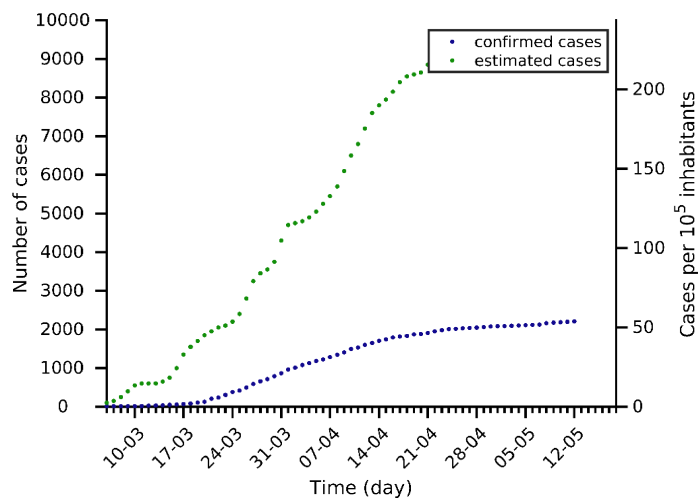
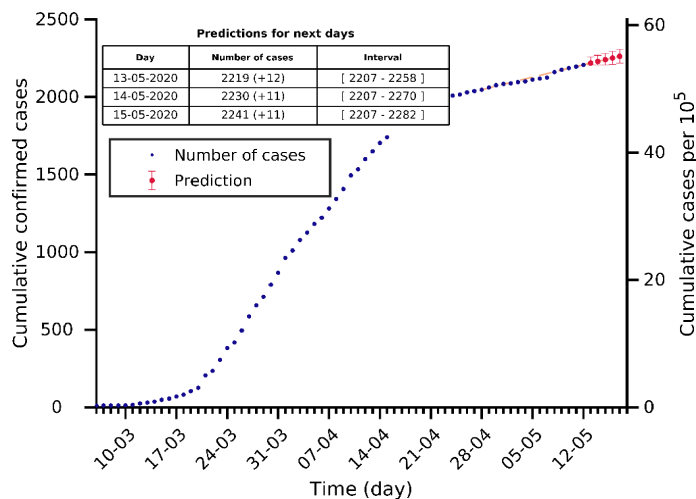
Hungary 12-05-2020. Population: 9.7M. Current cumulated incidence: 35/10⁵



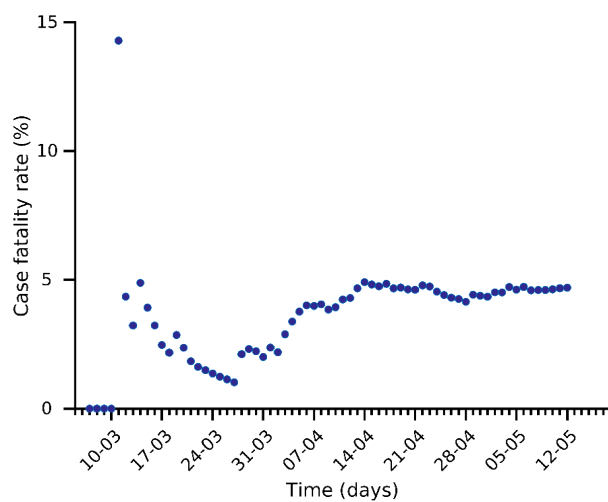
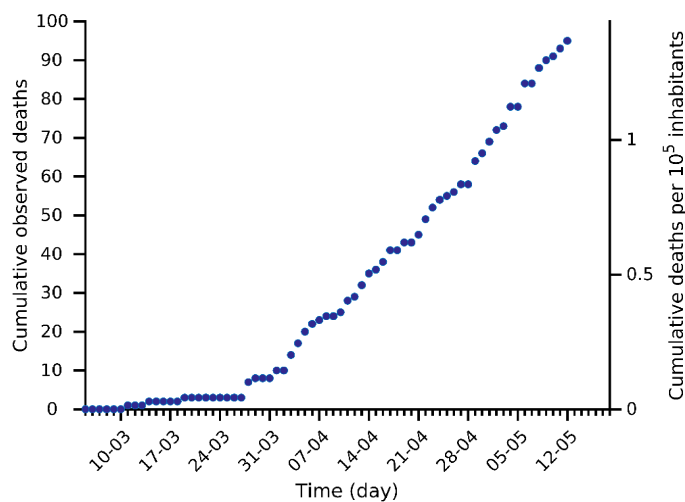
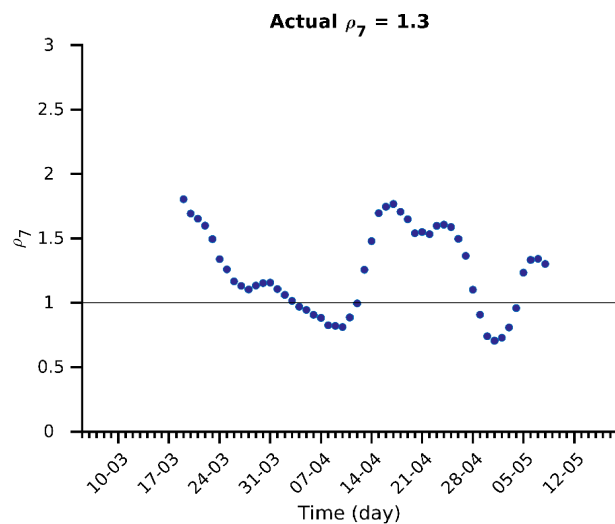
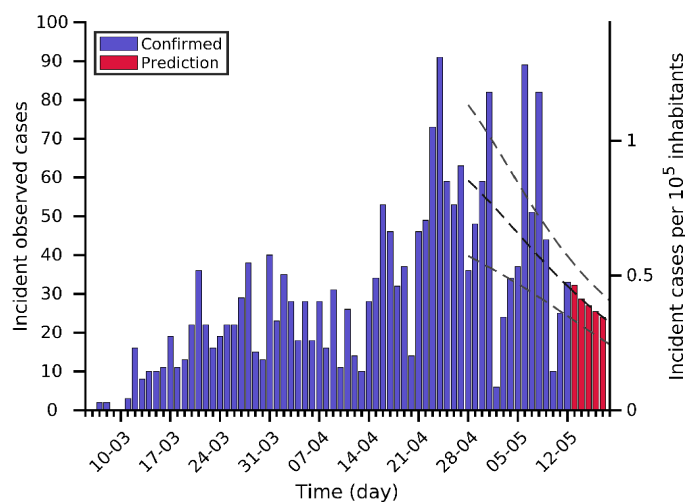
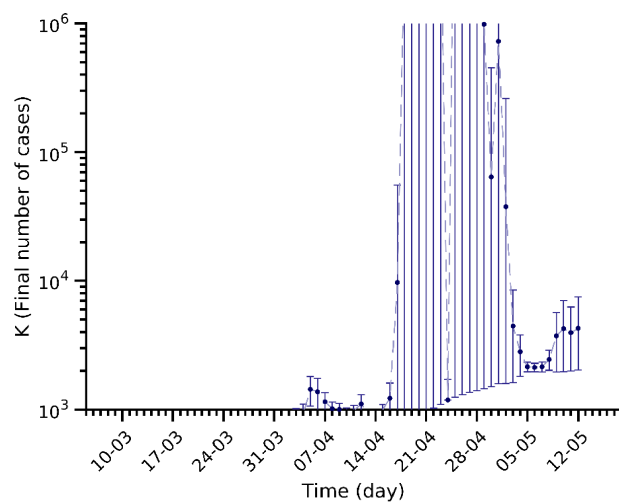
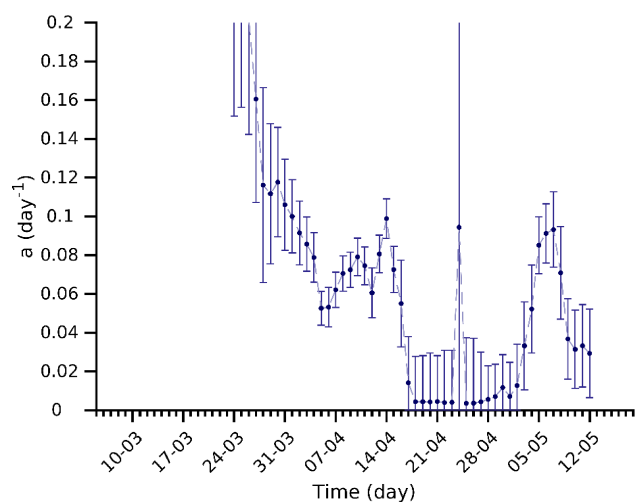
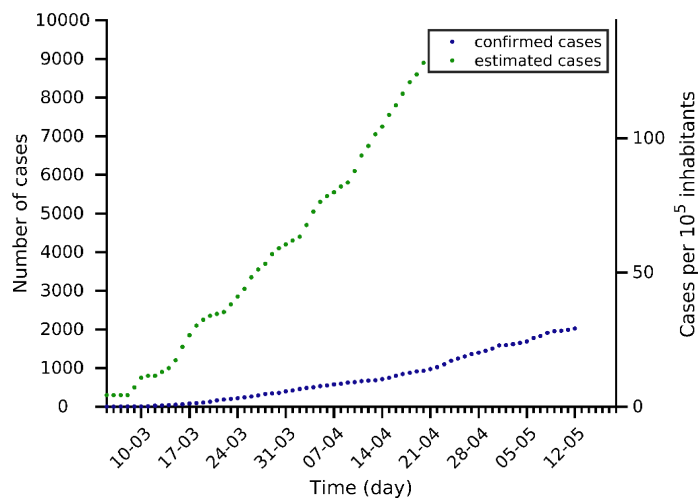
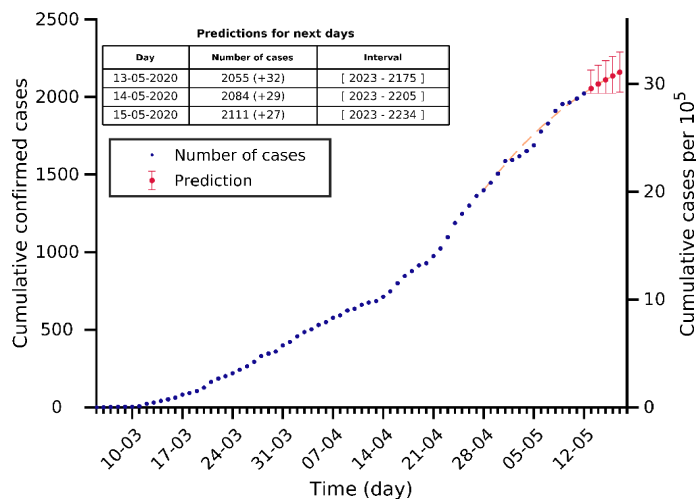
Greece 12-05-2020. Population: 10.4M. Current cumulated incidence: 26/10⁵



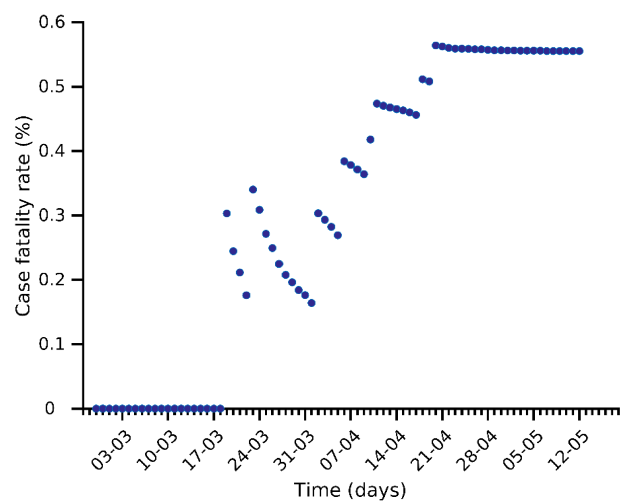
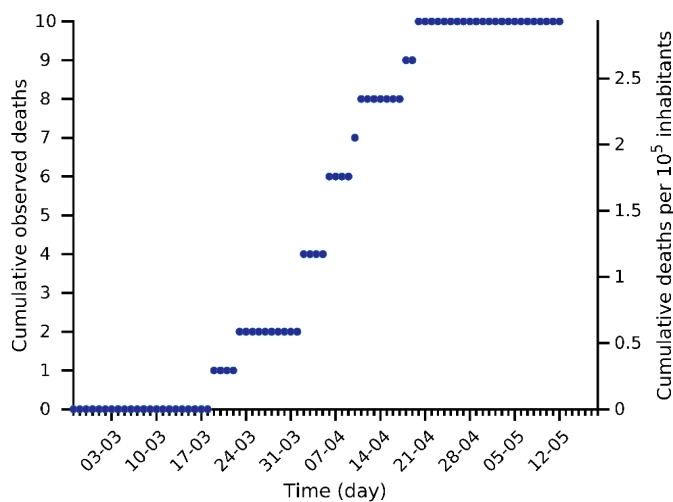
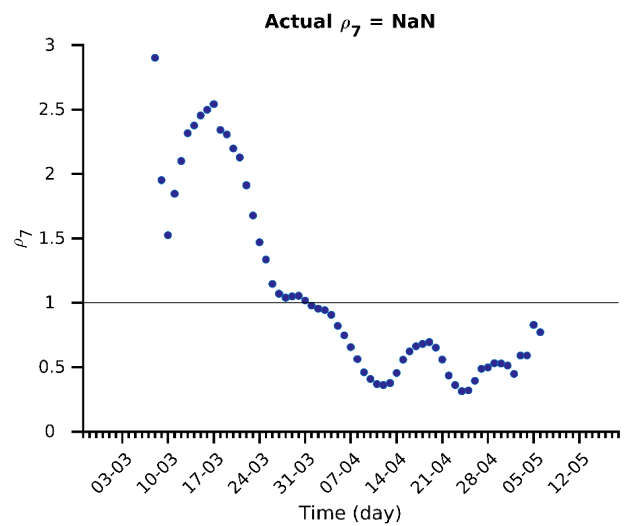
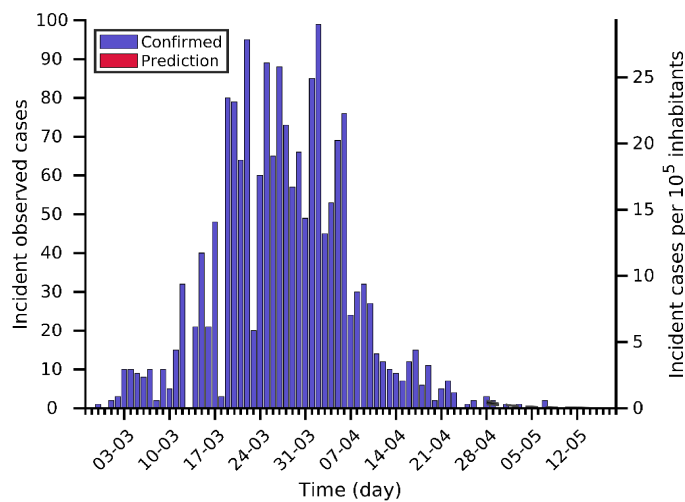
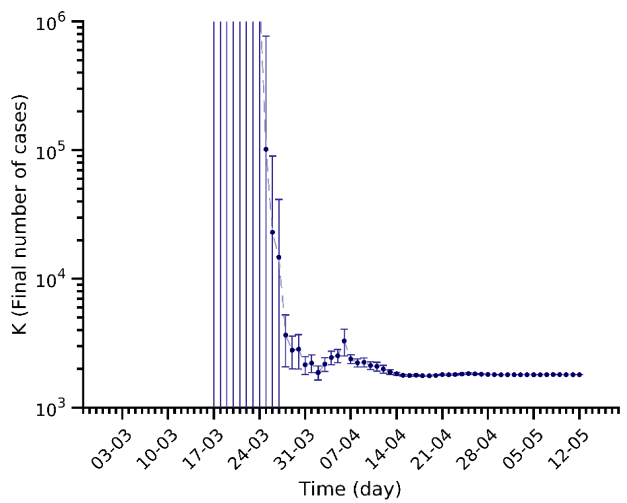
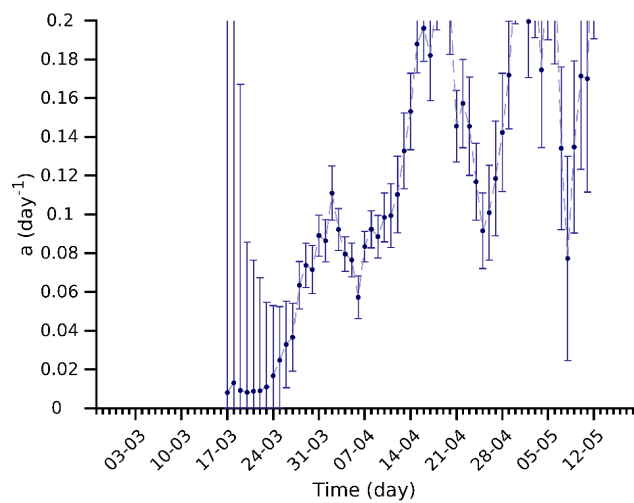
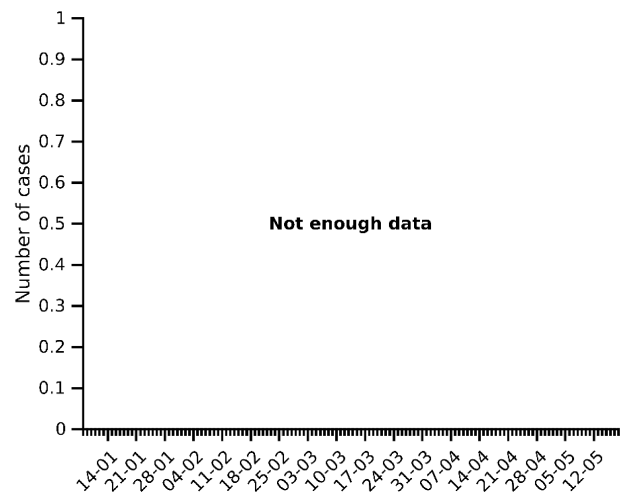
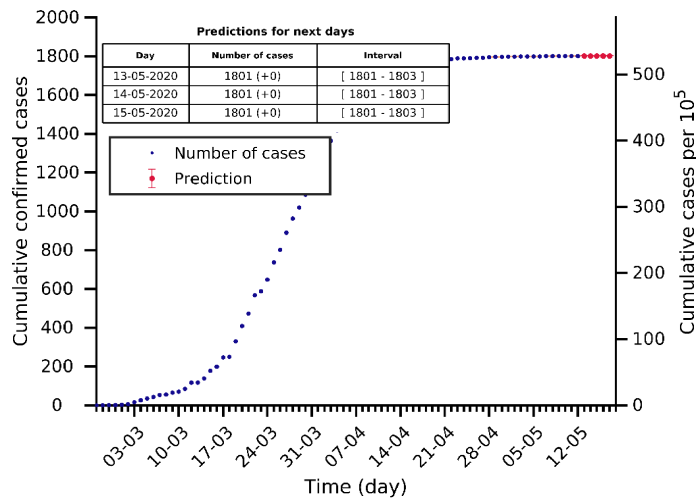
Croatia 12-05-2020. Population: 4.1M. Current cumulated incidence: 54/10⁵



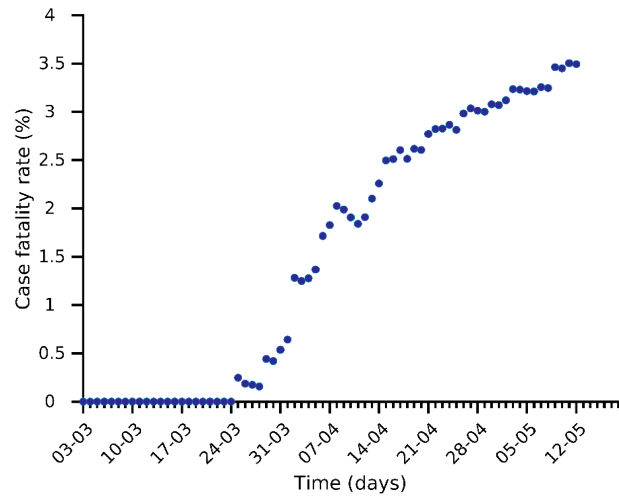
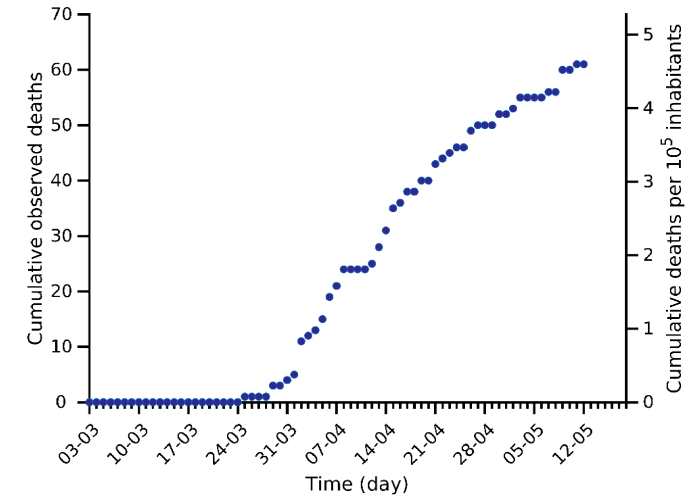
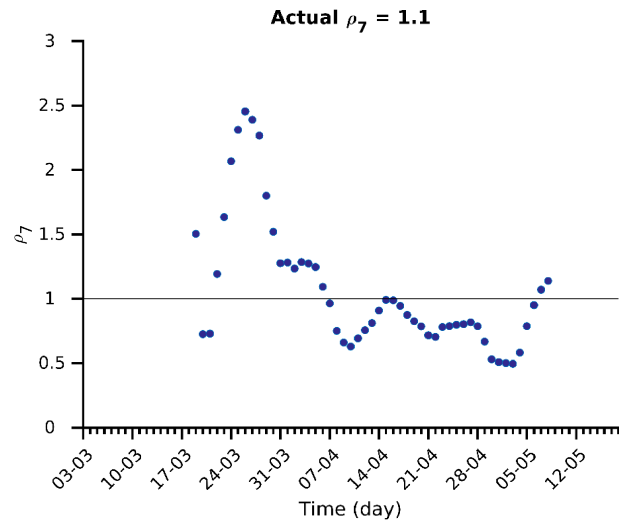
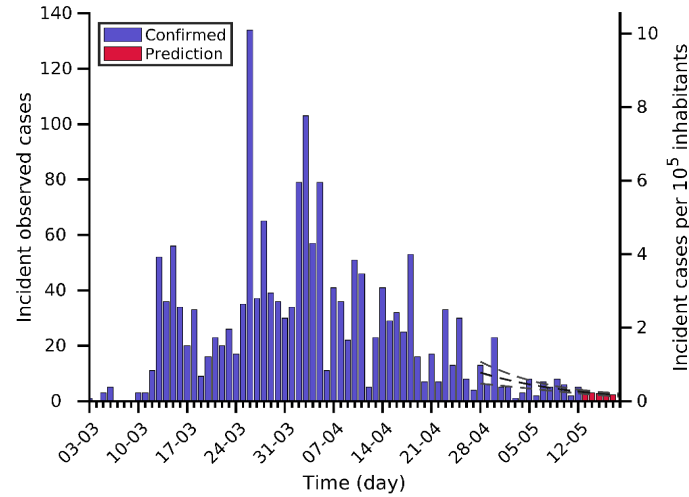
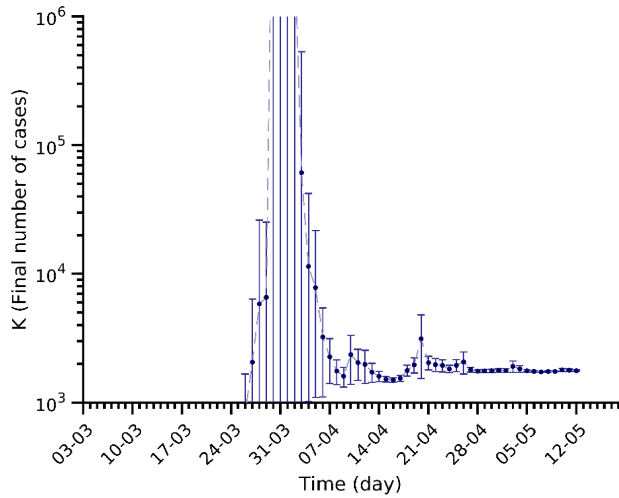
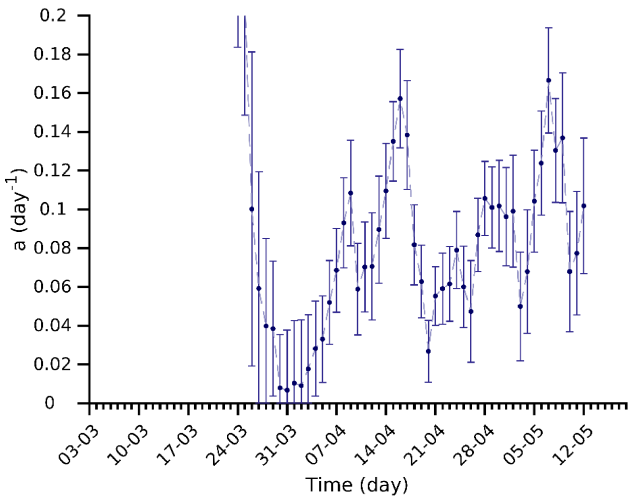
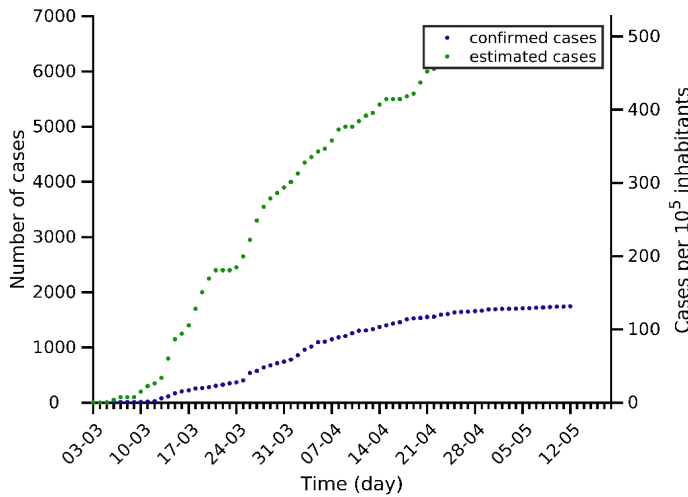
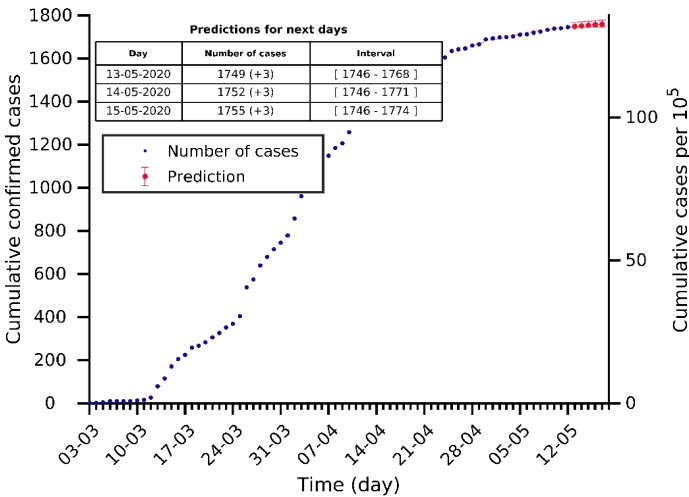
Bulgaria 12-05-2020. Population: 6.9M. Current cumulated incidence: 29/10⁵



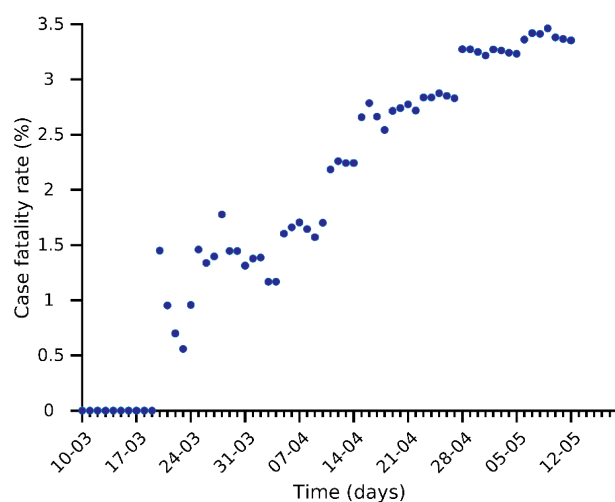
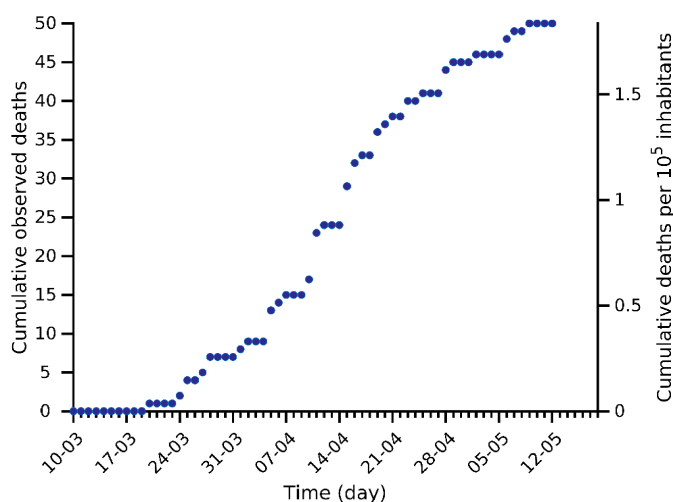
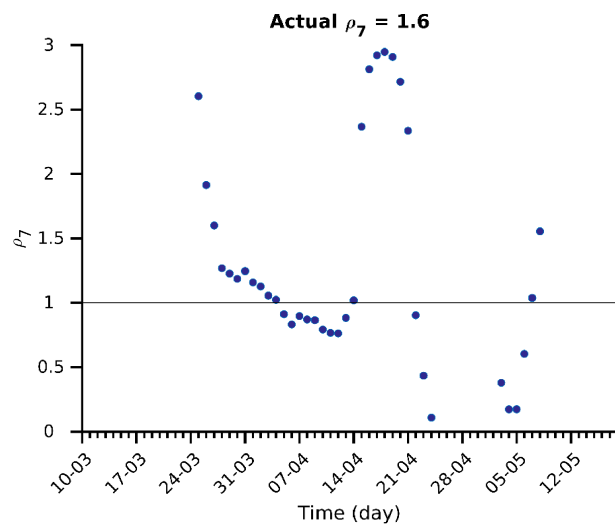
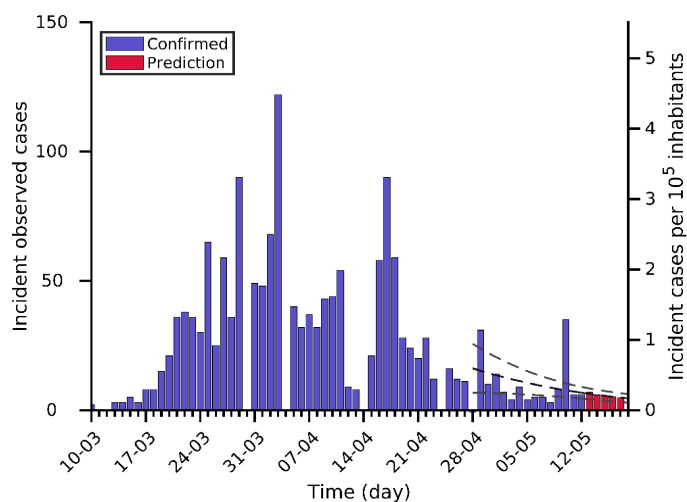
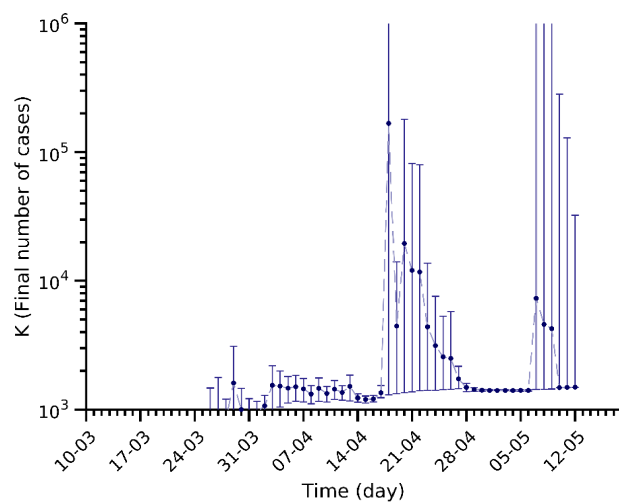
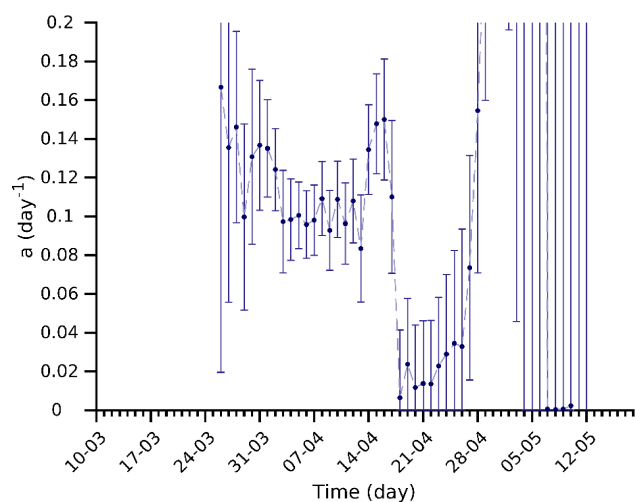
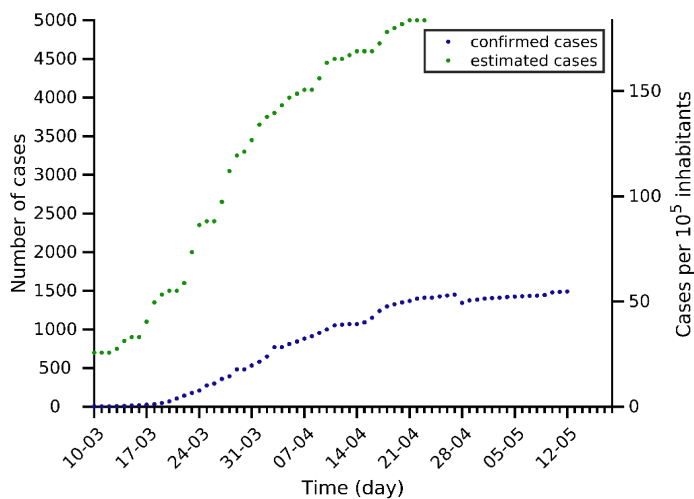
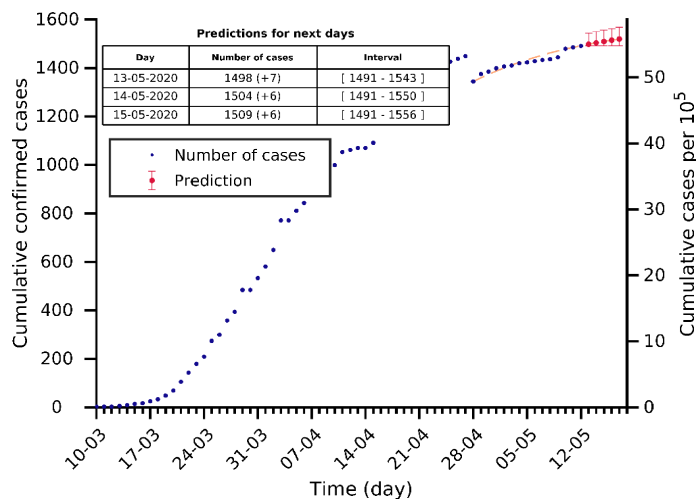
Iceland 12-05-2020. Population: 0.3M. Current cumulated incidence: 528/10⁵



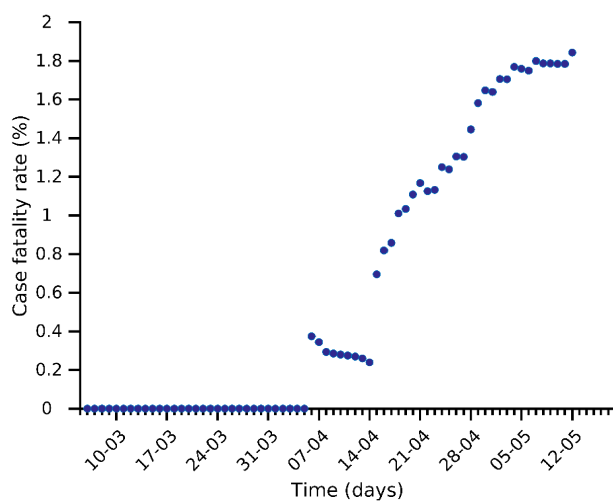
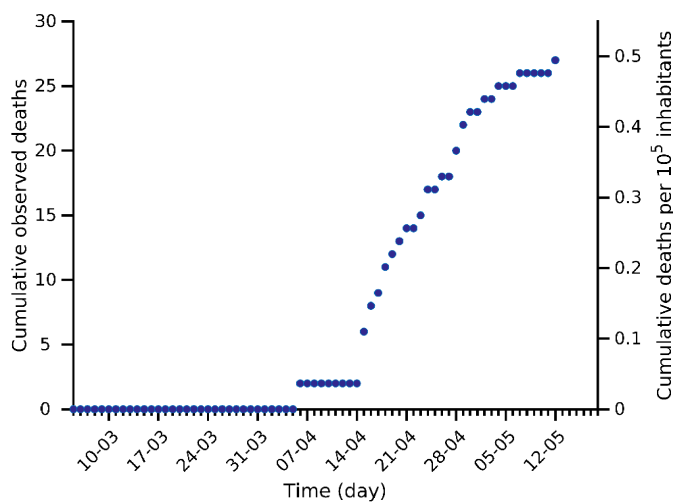
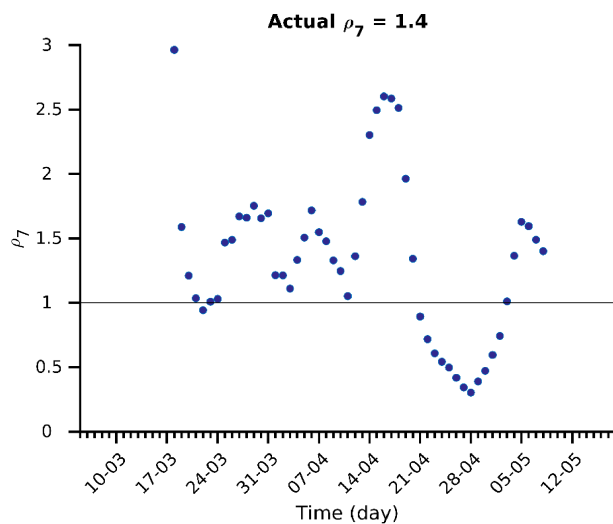
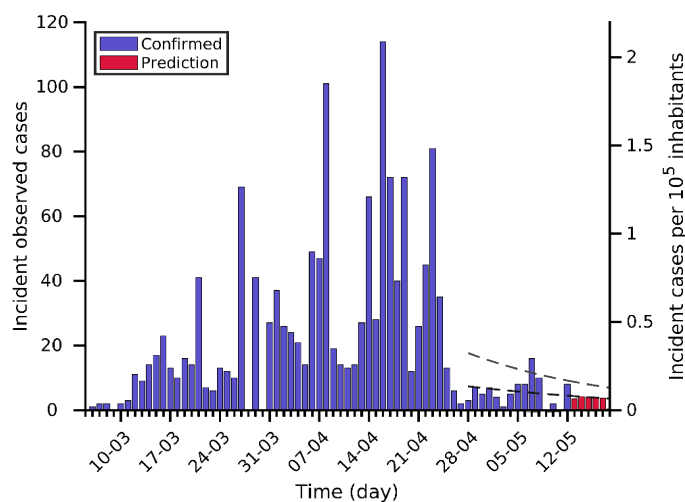
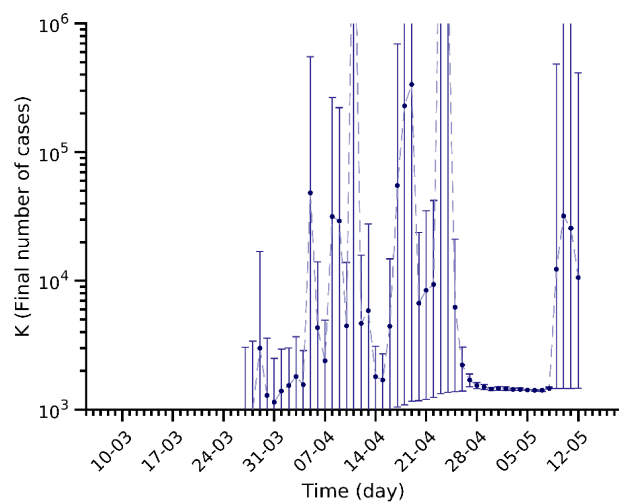
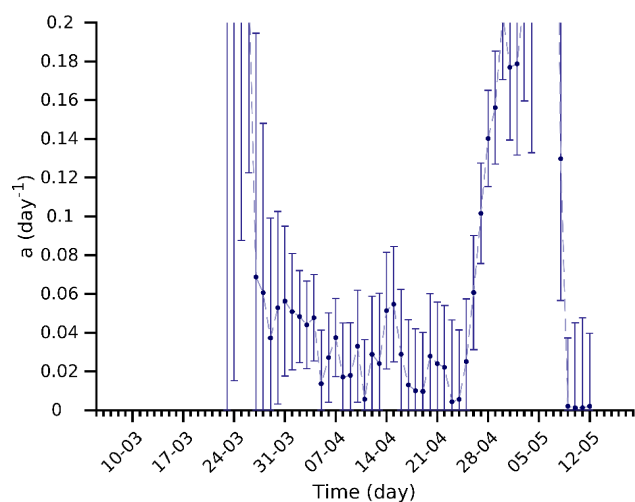
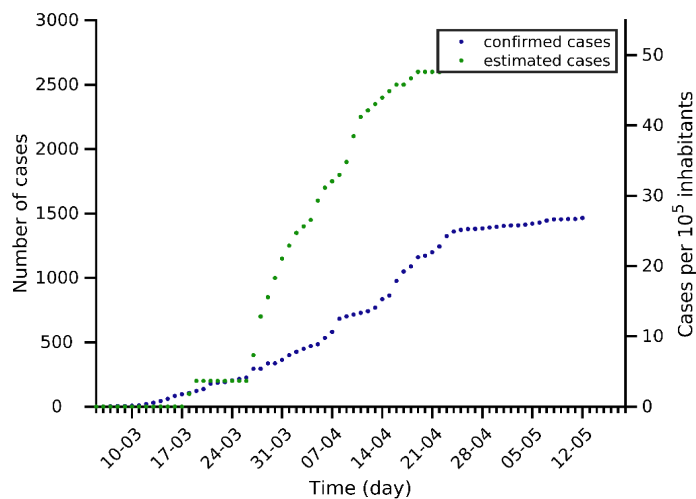
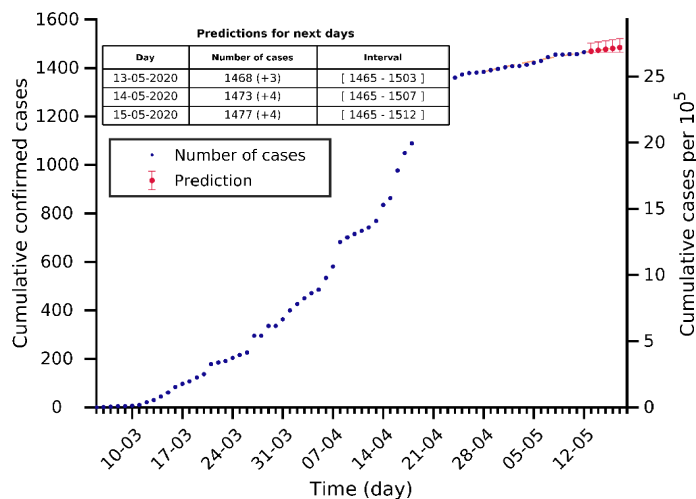
Estonia 12-05-2020. Population: 1.3M. Current cumulated incidence: 132/10⁵



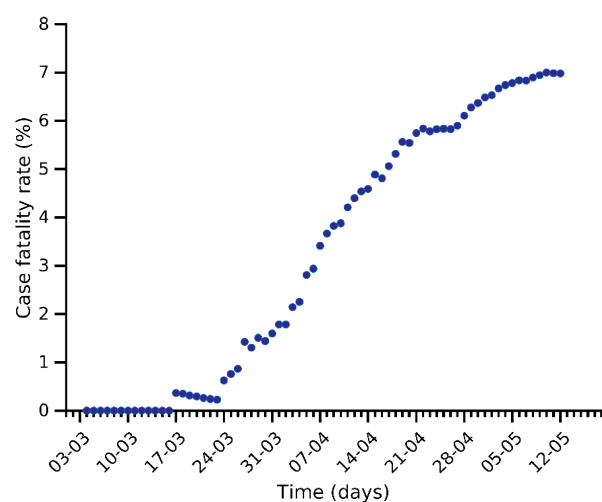
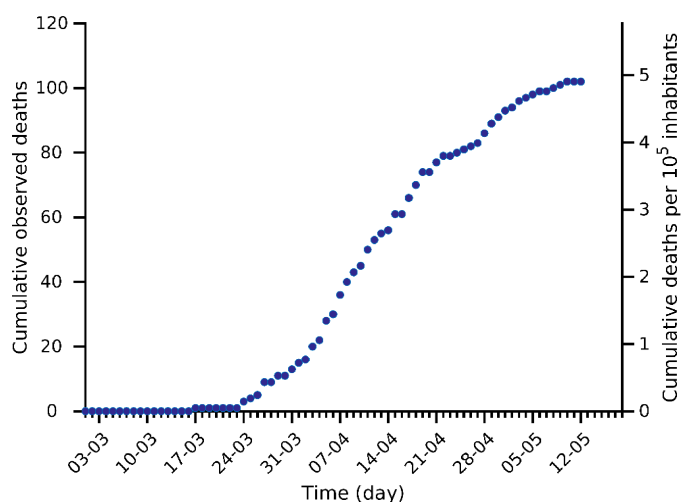
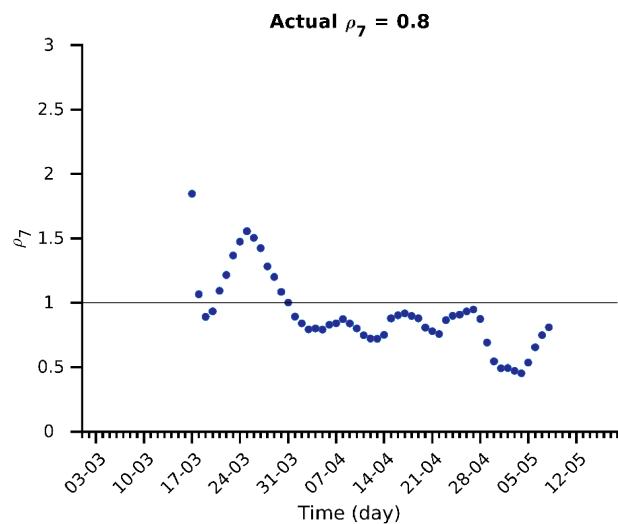
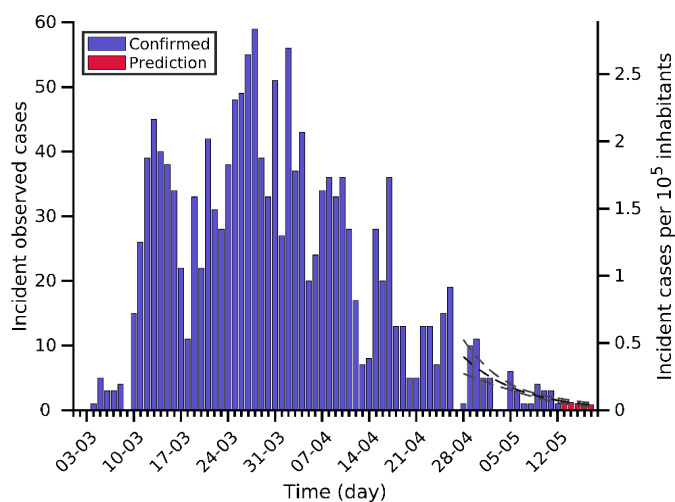
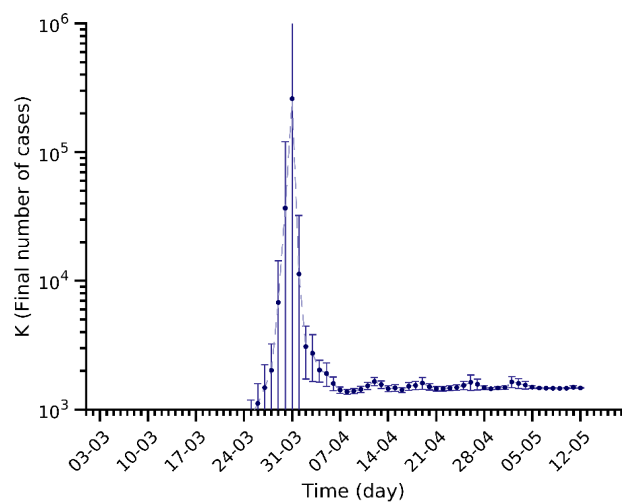
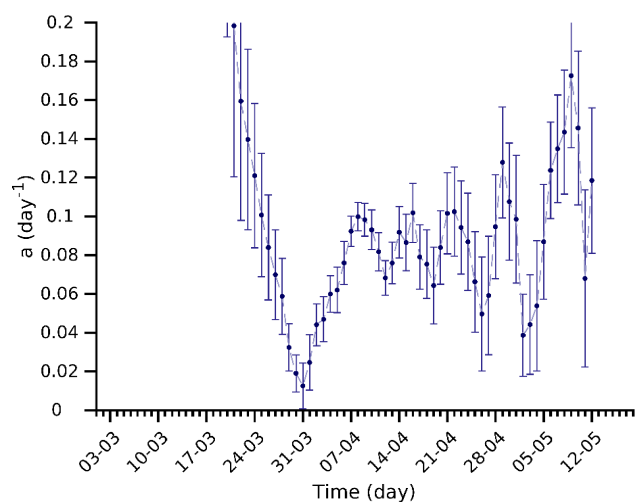
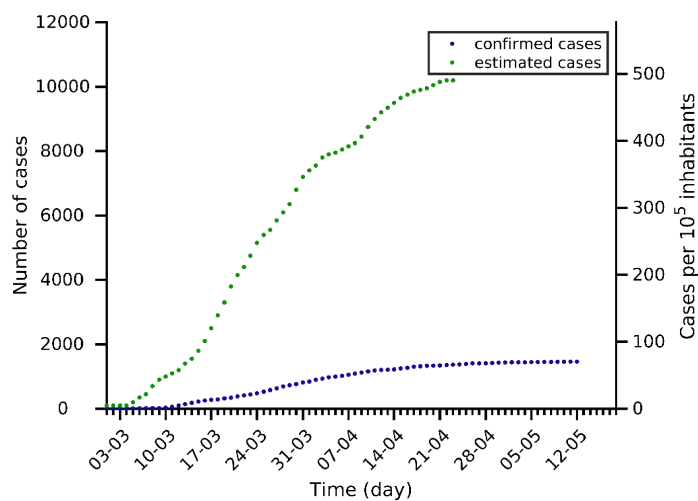
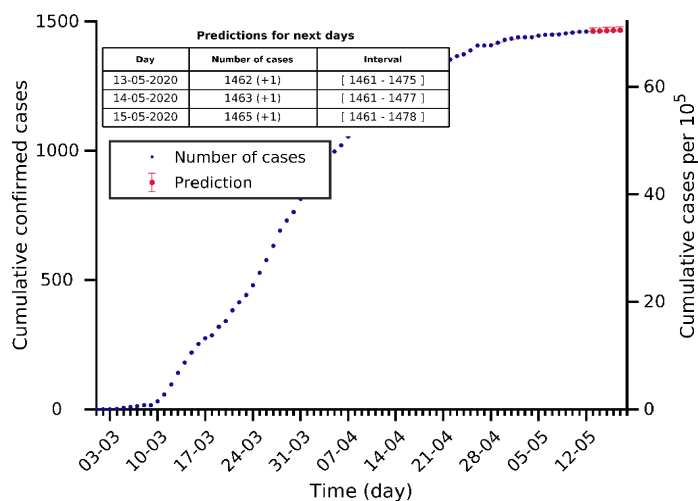
Lithuania 12-05-2020. Population: 2.7M. Current cumulated incidence: 55/10⁵



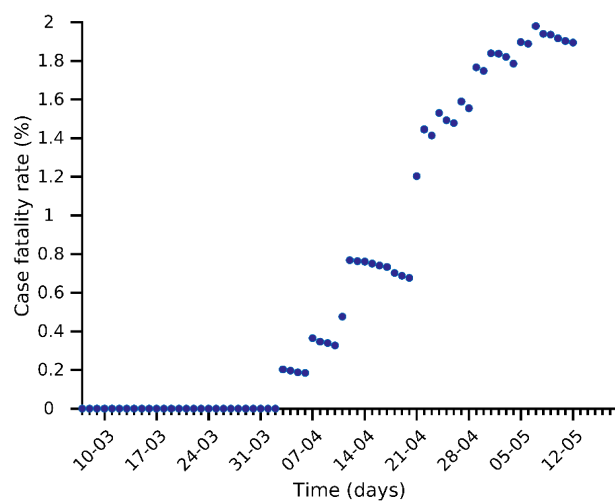
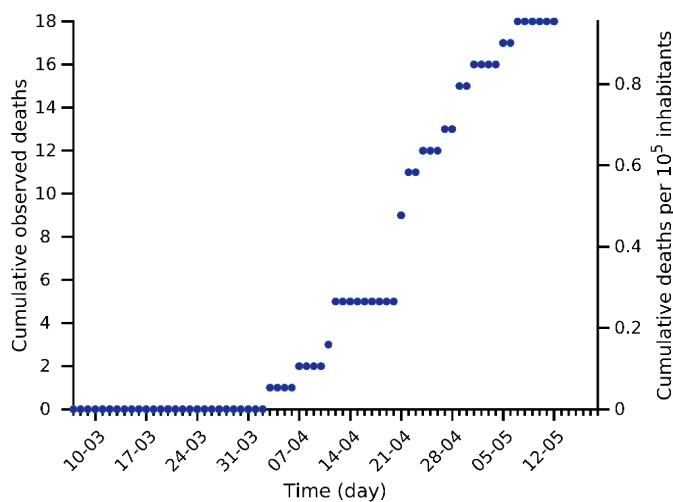
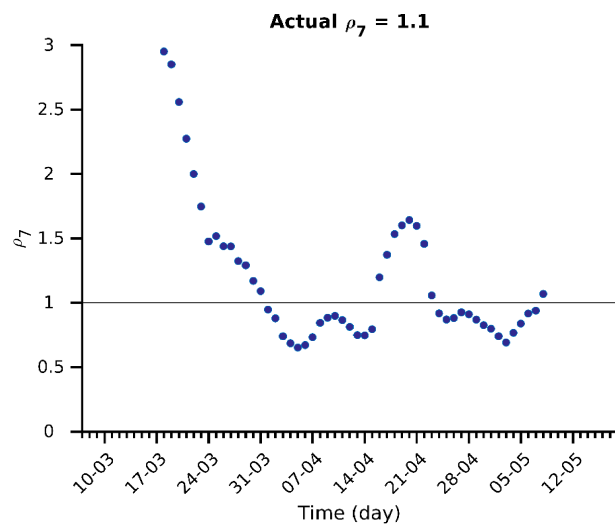
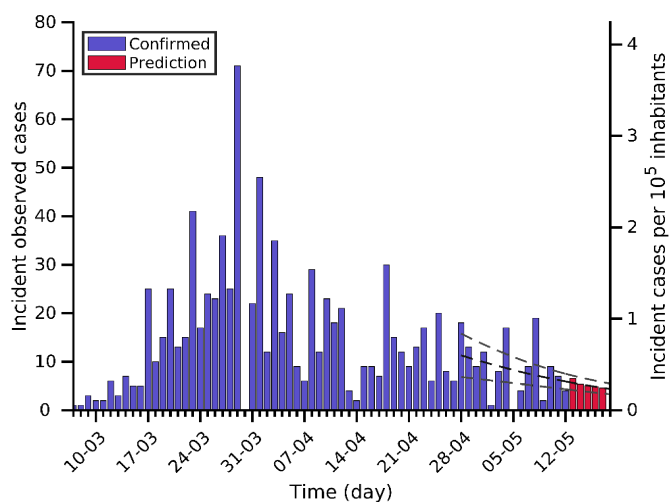
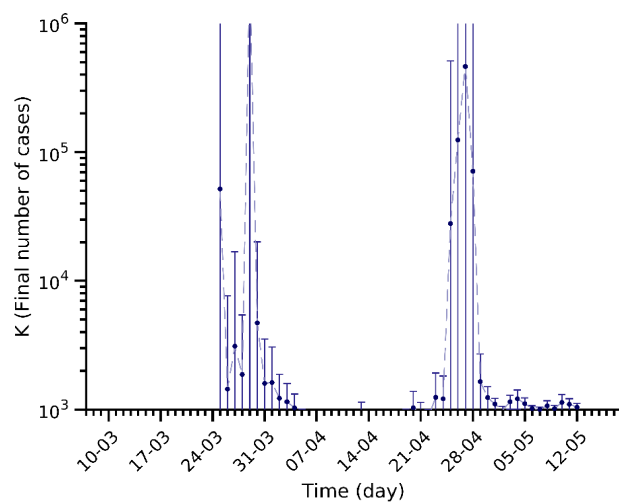
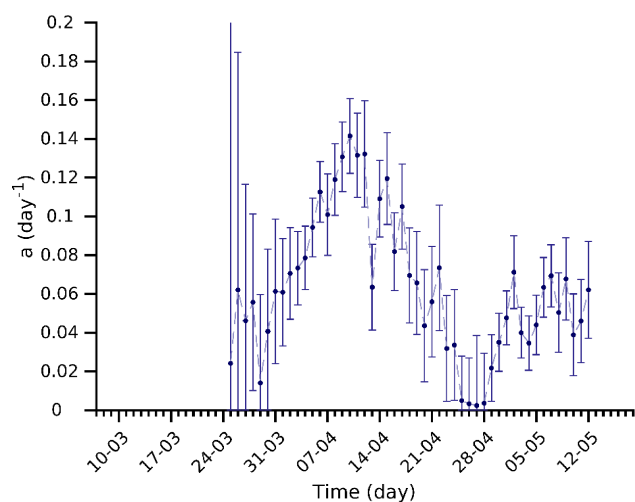
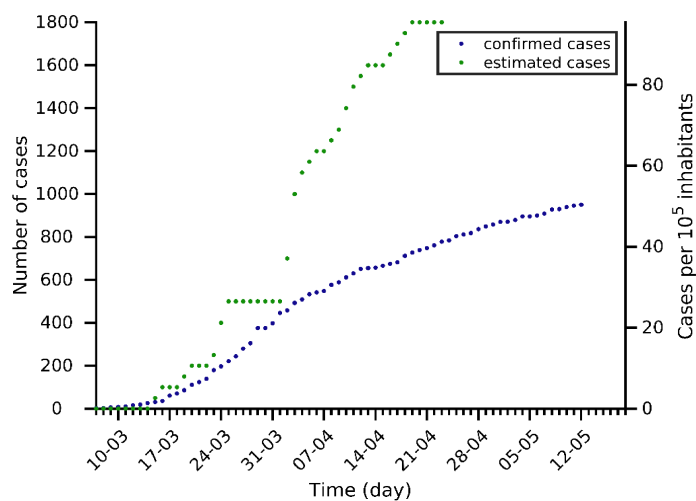
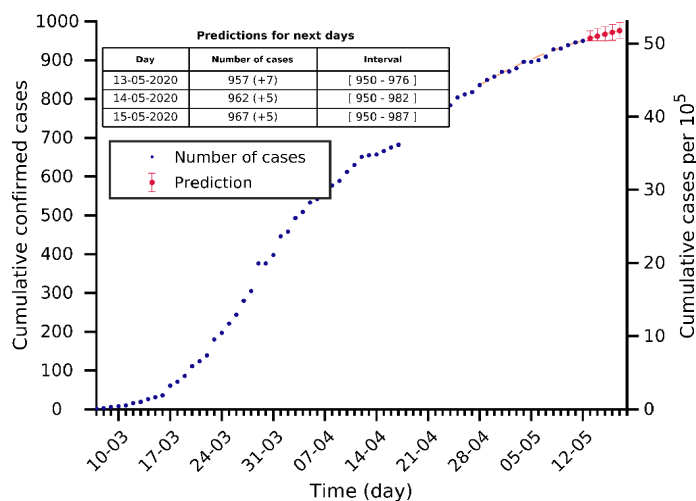
Slovakia 12-05-2020. Population: 5.5M. Current cumulated incidence: 27/10⁵



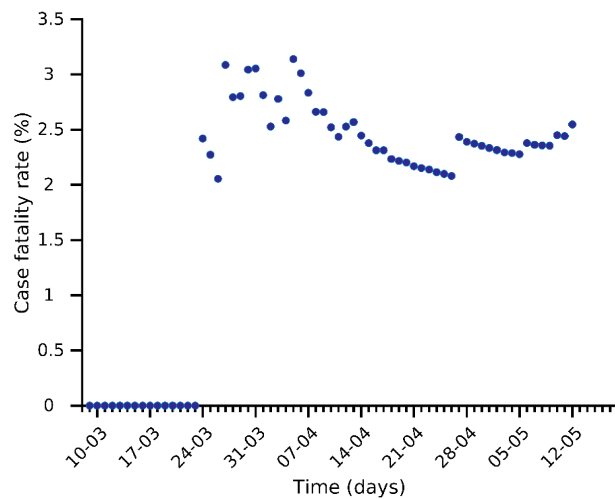
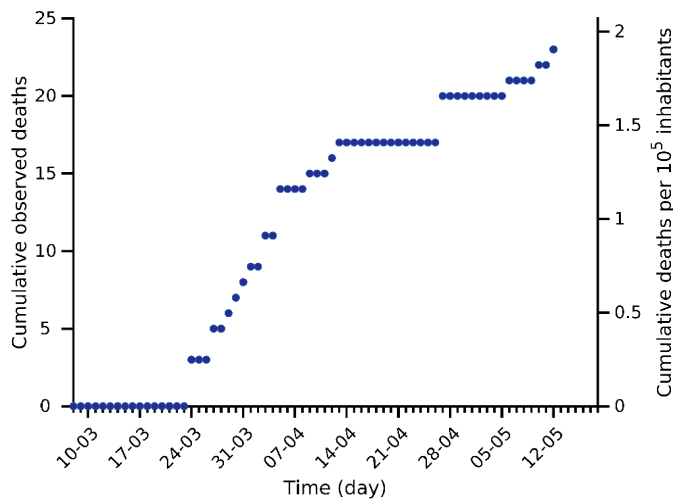
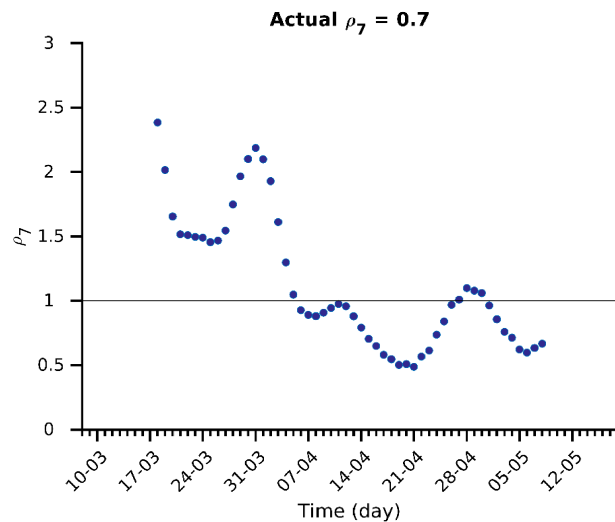
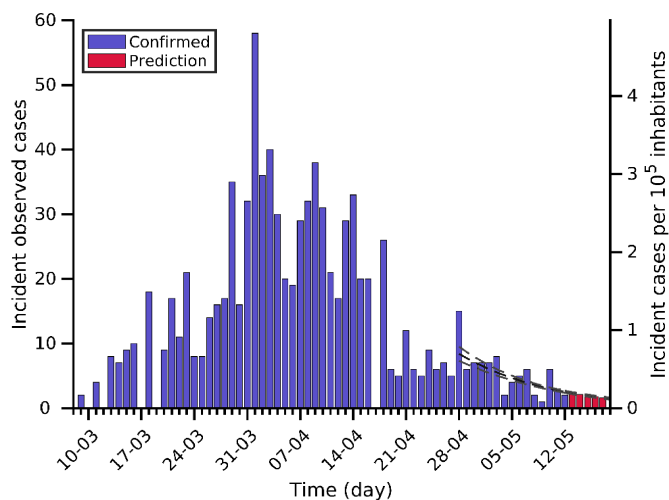
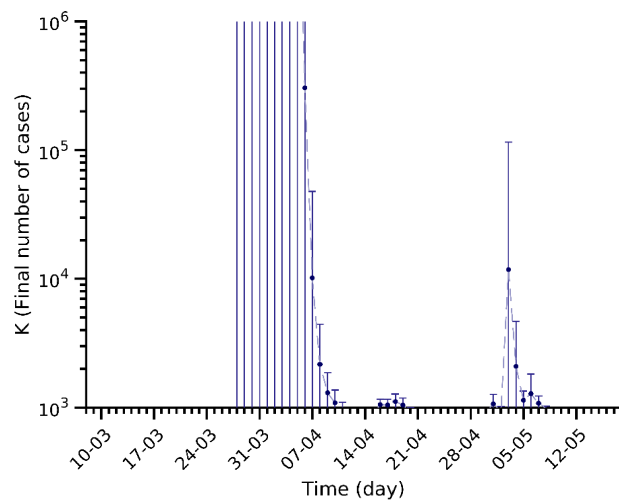
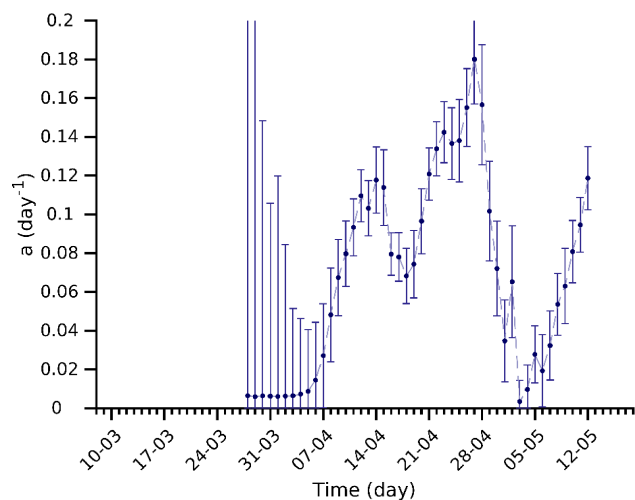
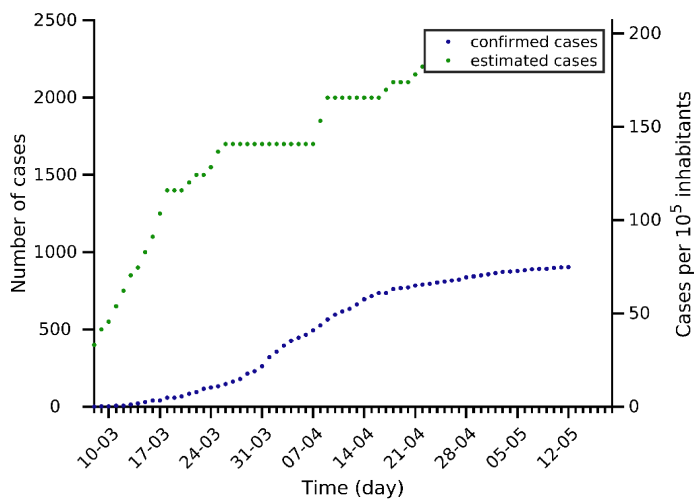
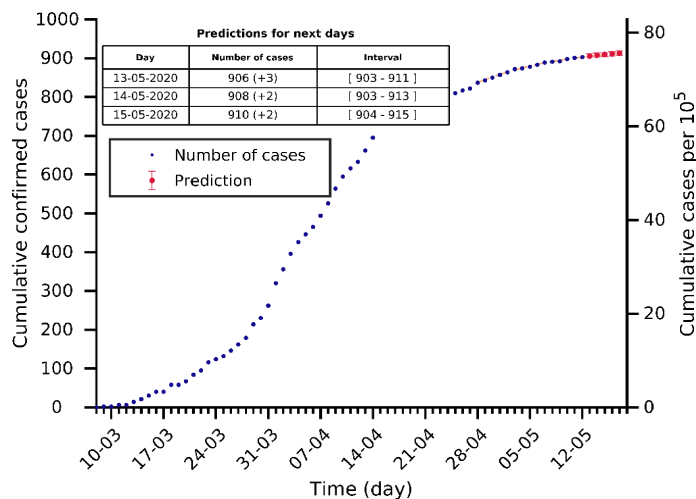
Slovenia 12-05-2020. Population: 2.1M. Current cumulated incidence: 70/10⁵



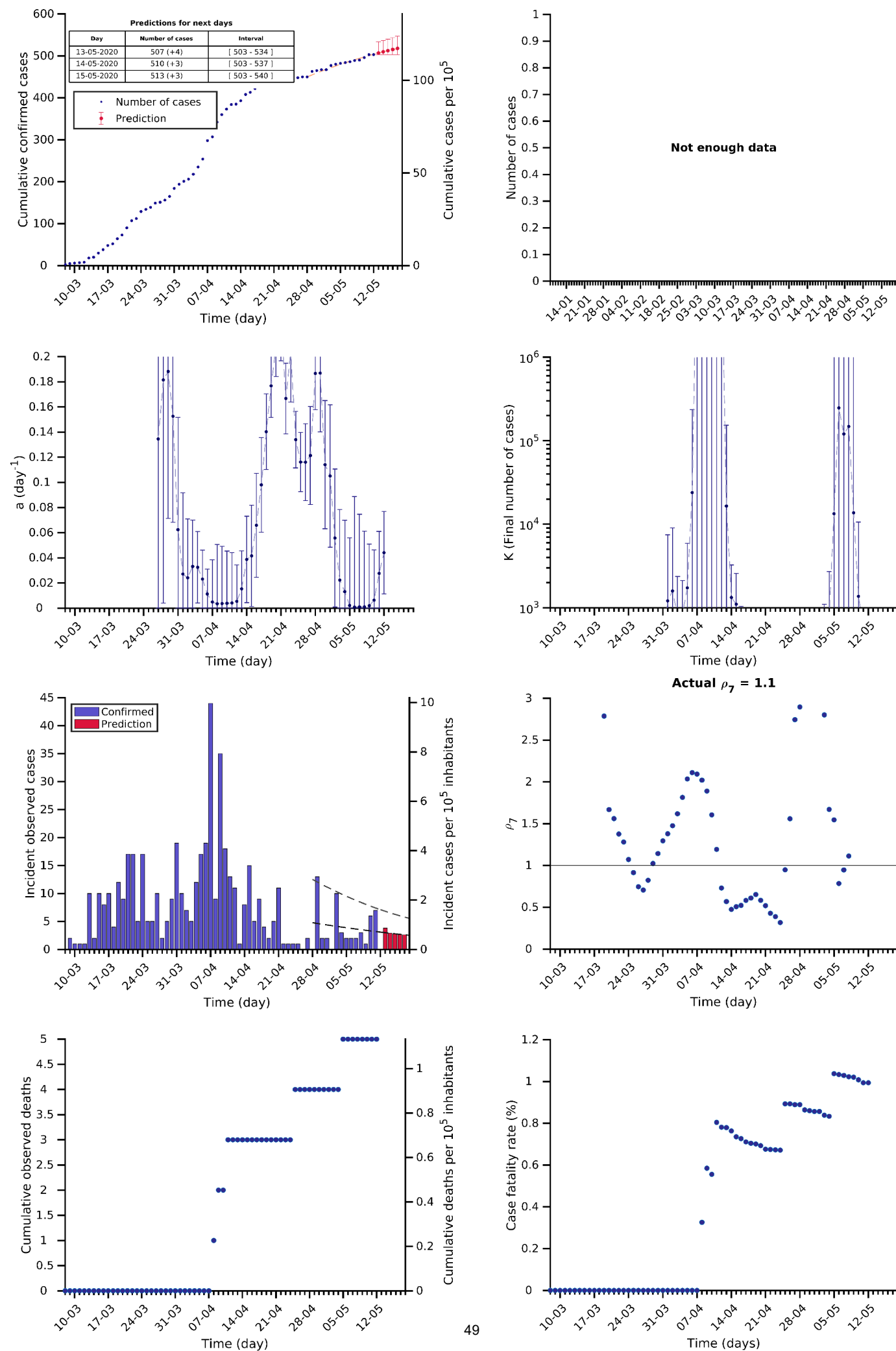
Latvia 12-05-2020. Population: 1.9M. Current cumulated incidence: 50/10⁵



Cyprus 12-05-2020. Population: 1.2M. Current cumulated incidence: 75/10⁵



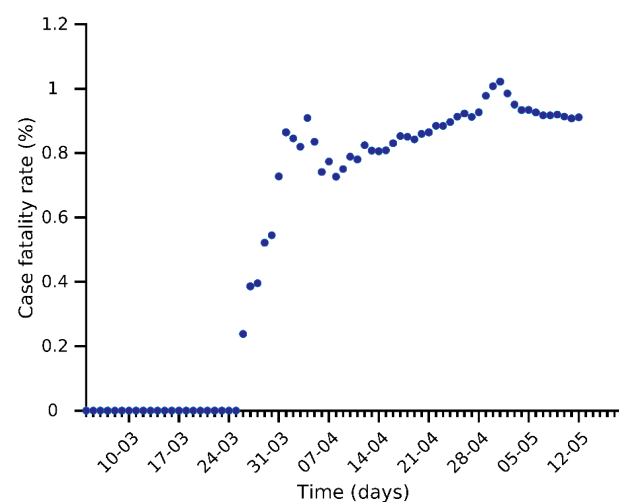
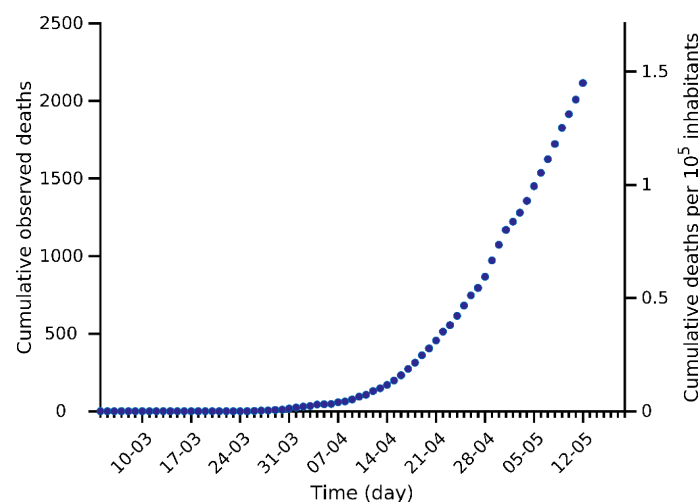
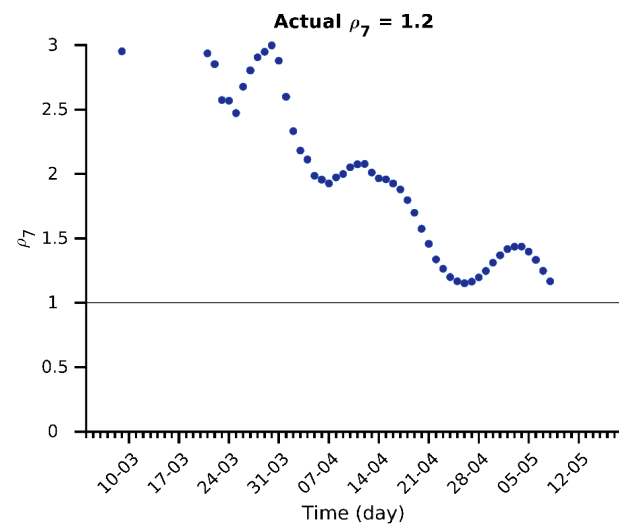
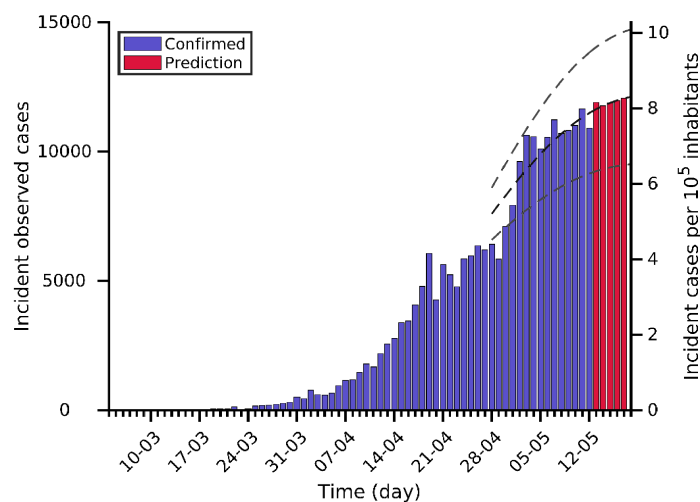
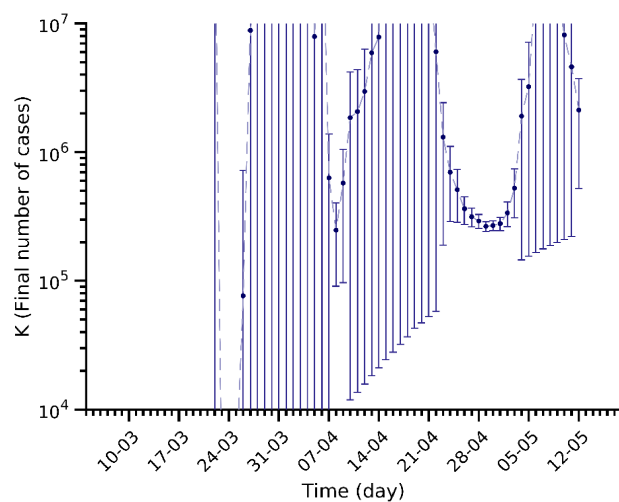
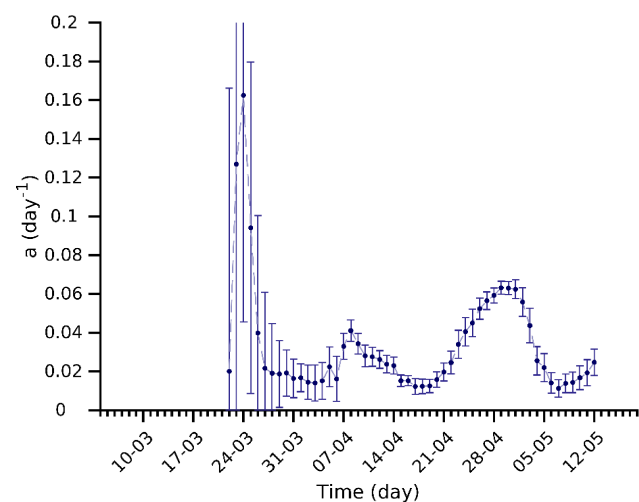
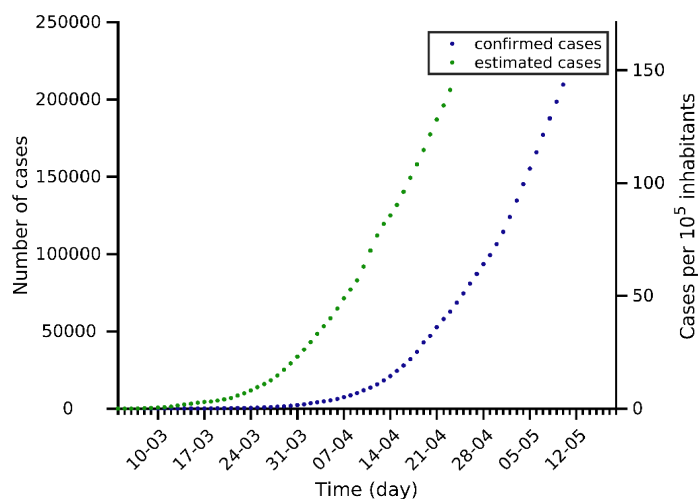
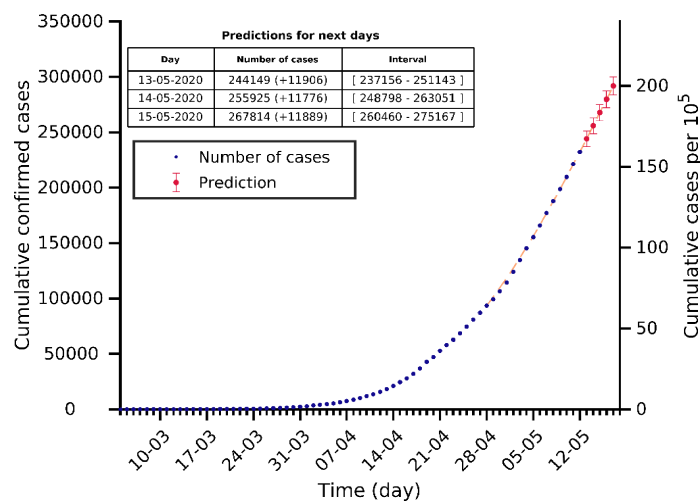
Malta 12-05-2020. Population: 0.4M. Current cumulated incidence: 114/10⁵



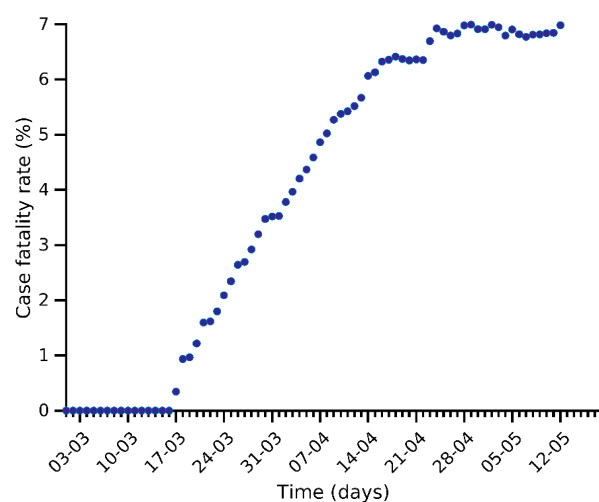
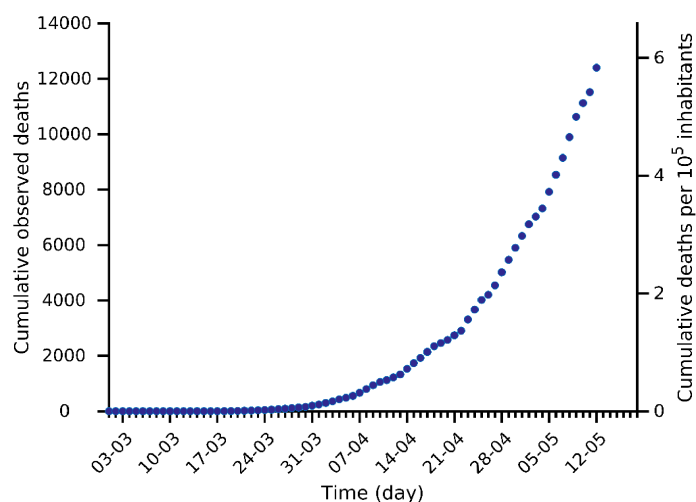
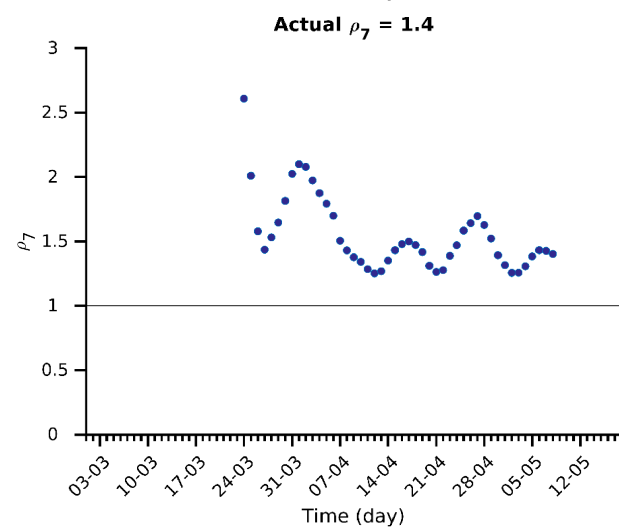
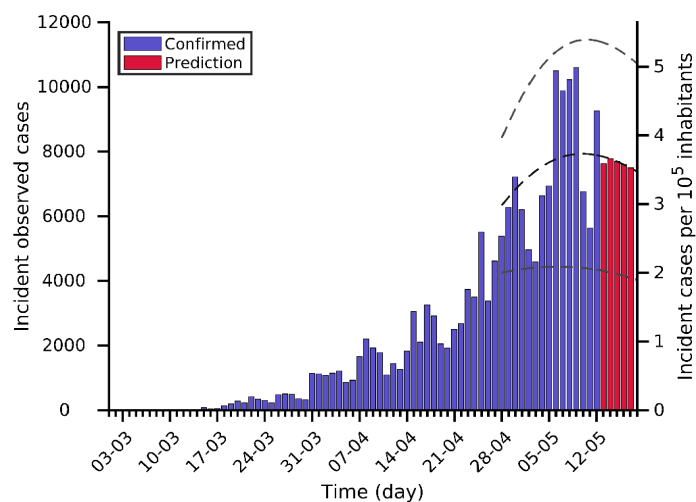
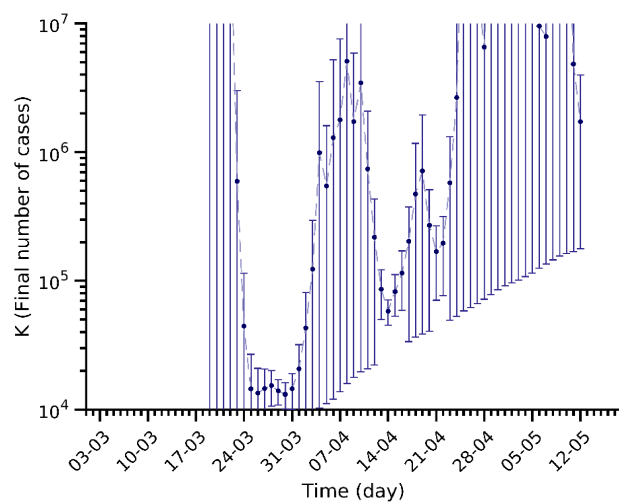
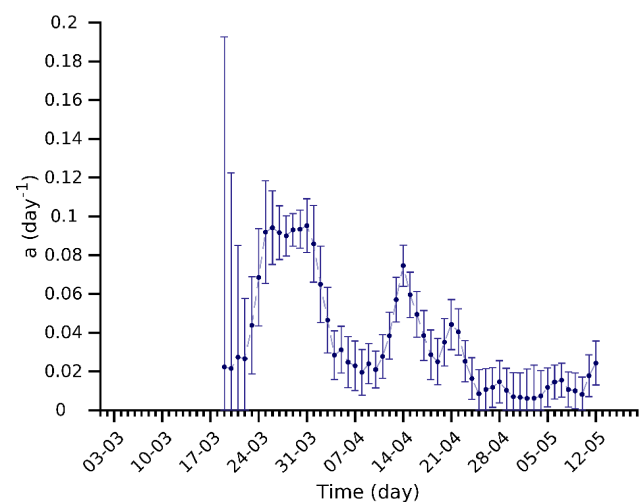
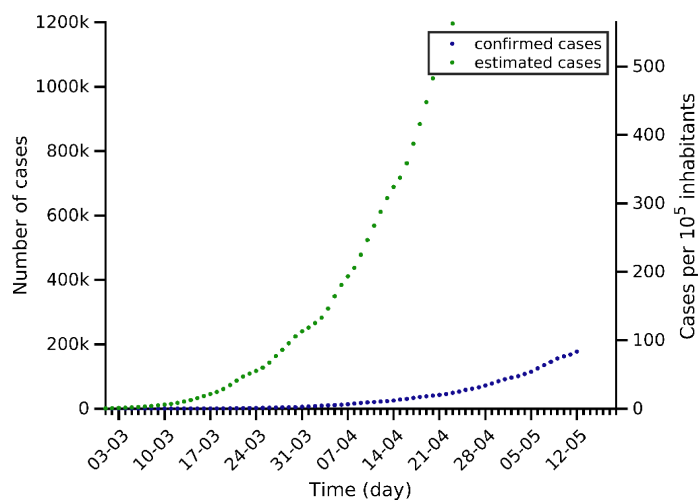
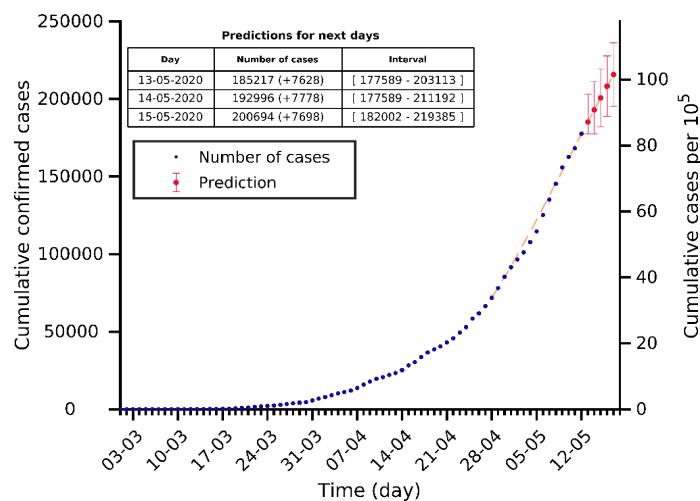
(2) Analysis and prediction of COVID-19 for other countries

Data obtained from <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>

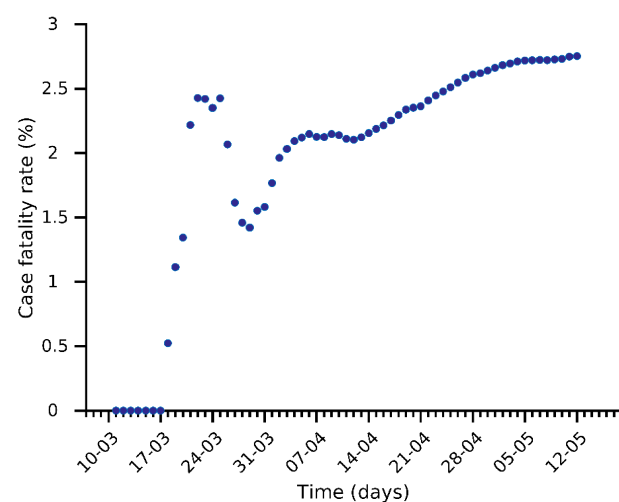
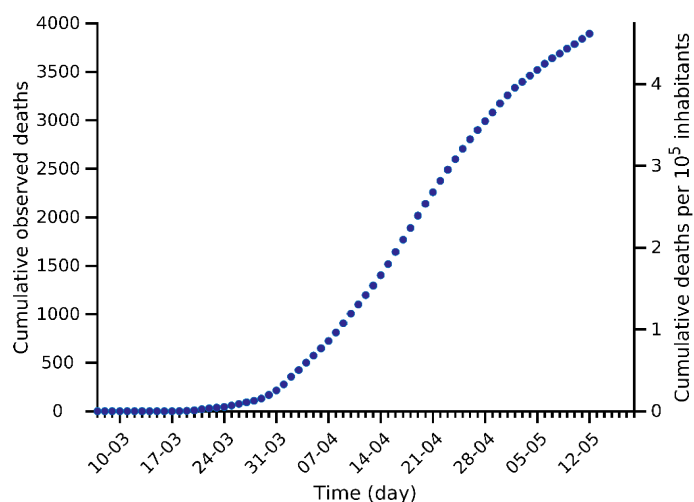
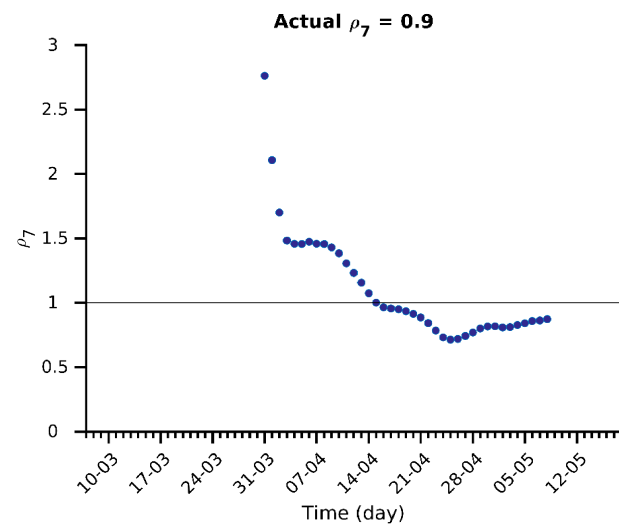
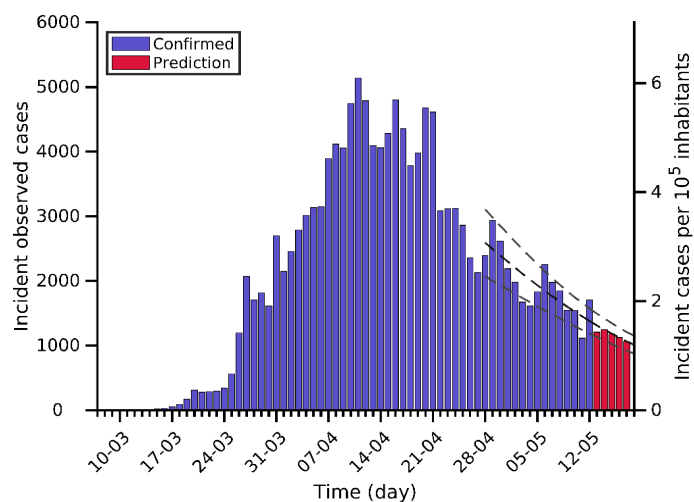
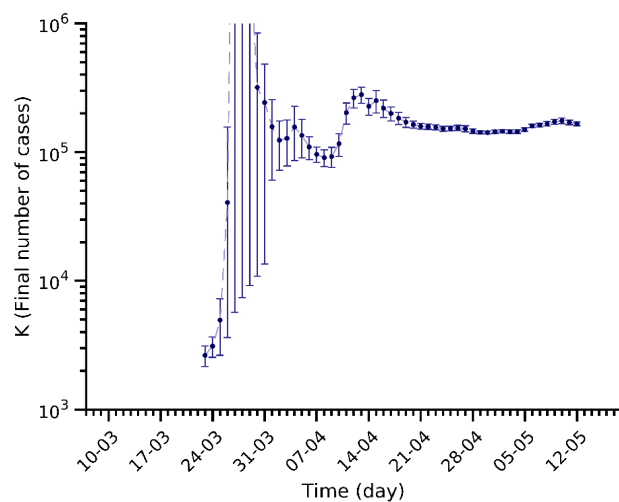
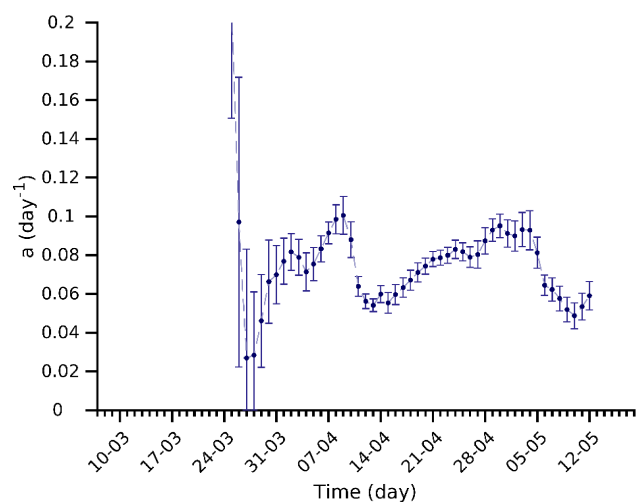
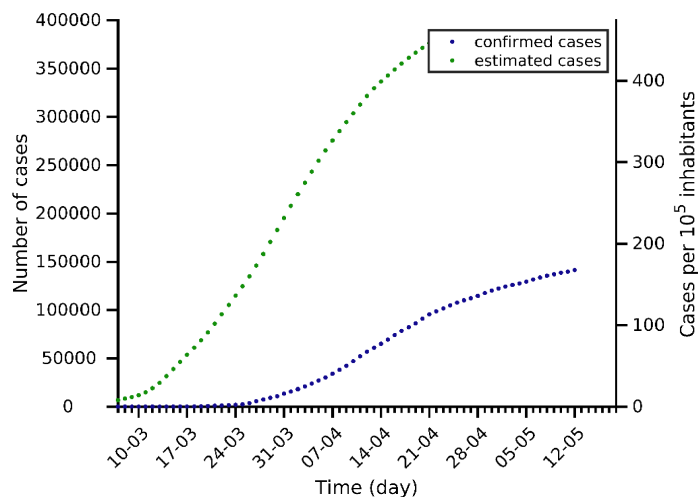
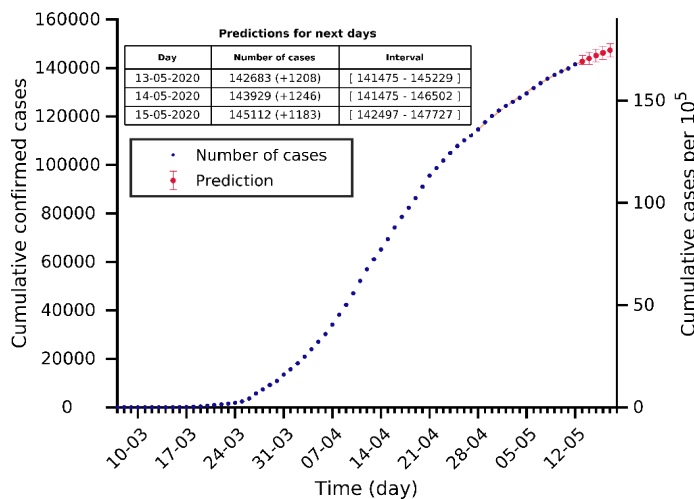
Russia 12-05-2020. Population: 145.9M. Current cumulated incidence: 159/10⁵



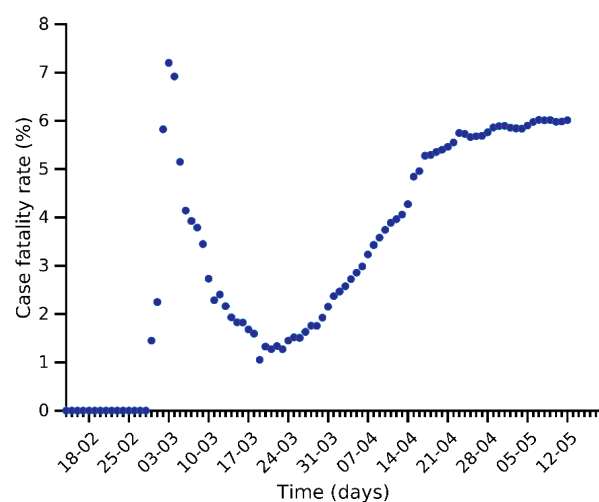
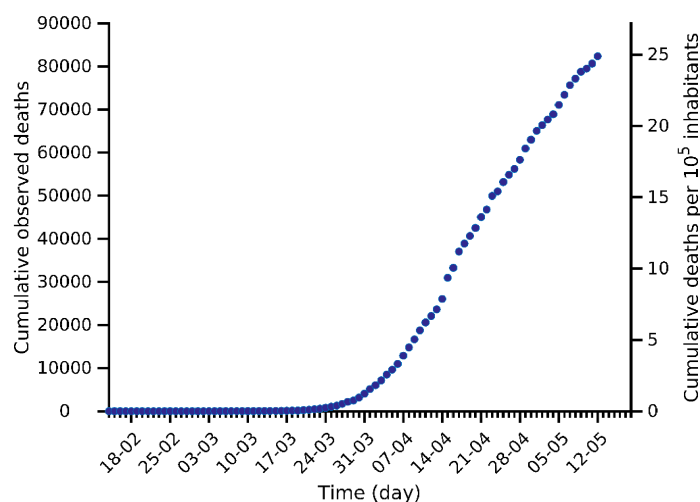
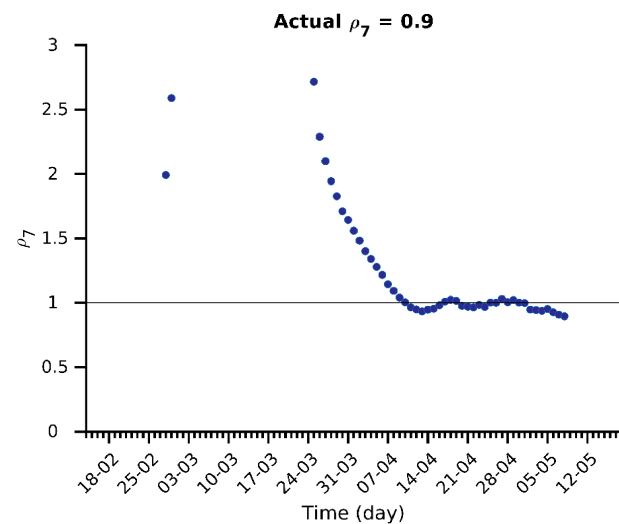
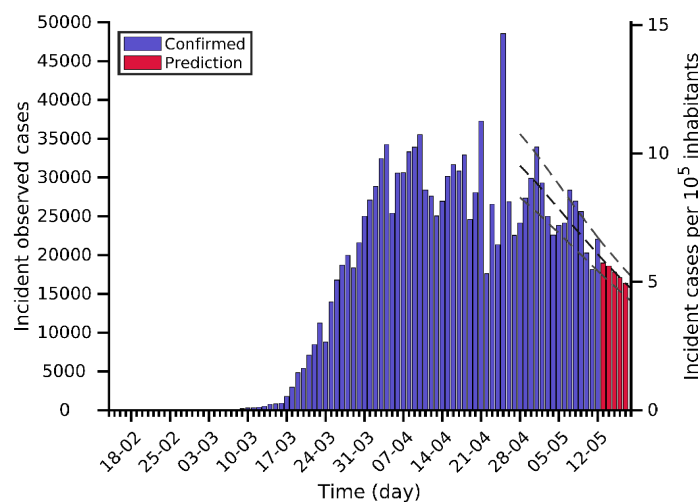
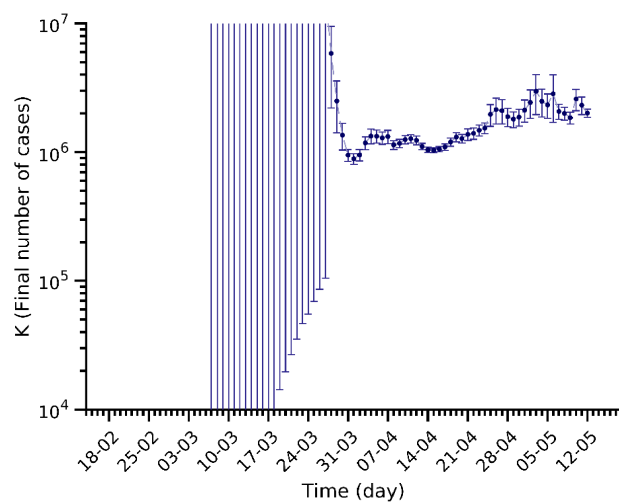
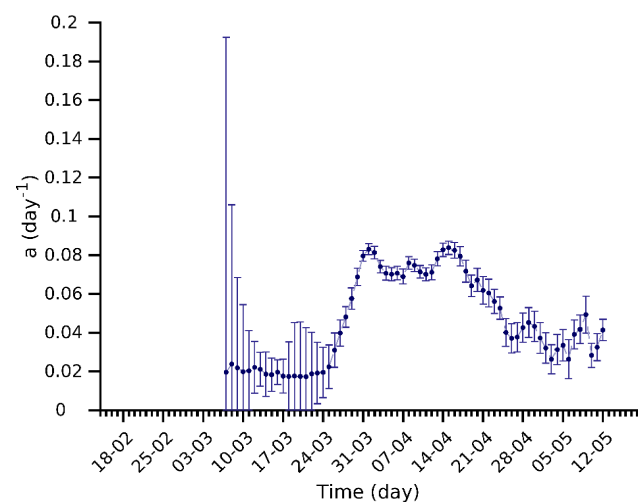
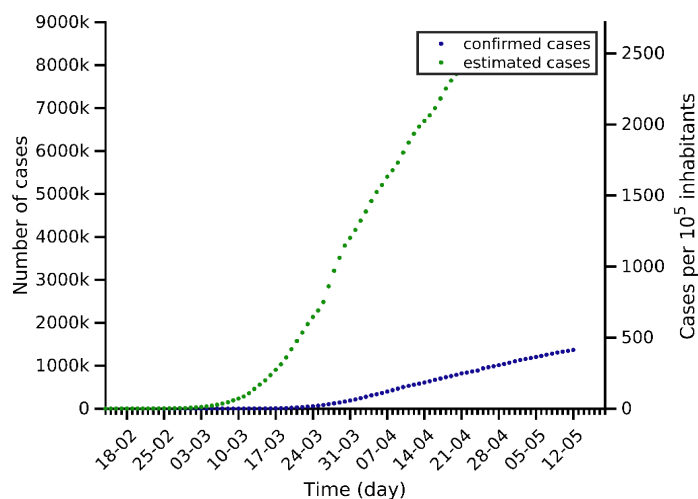
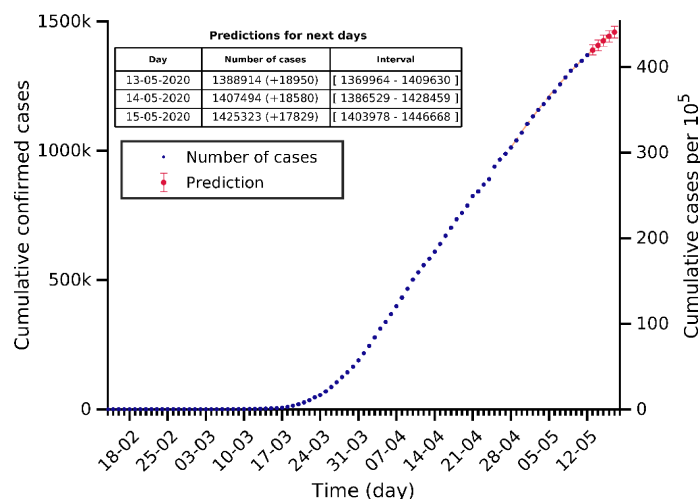
Brazil 12-05-2020. Population: 212.6M. Current cumulated incidence: 84/10⁵



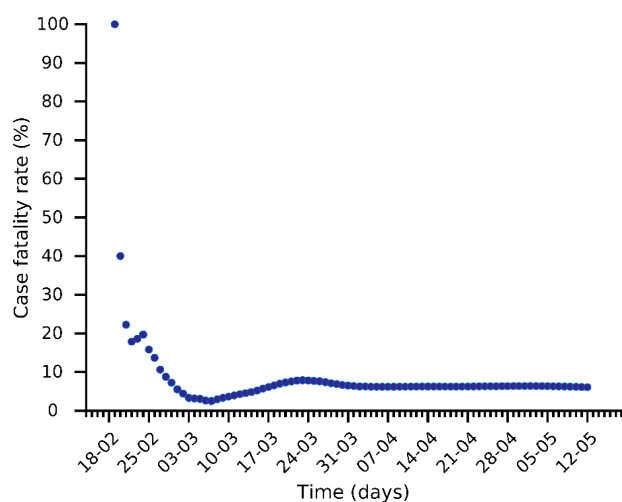
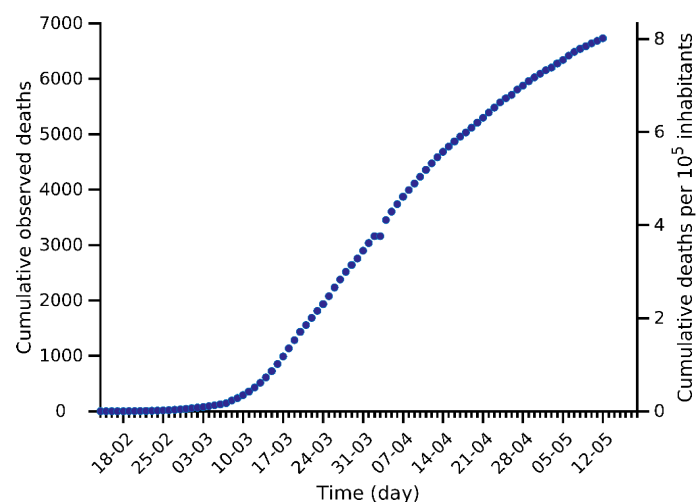
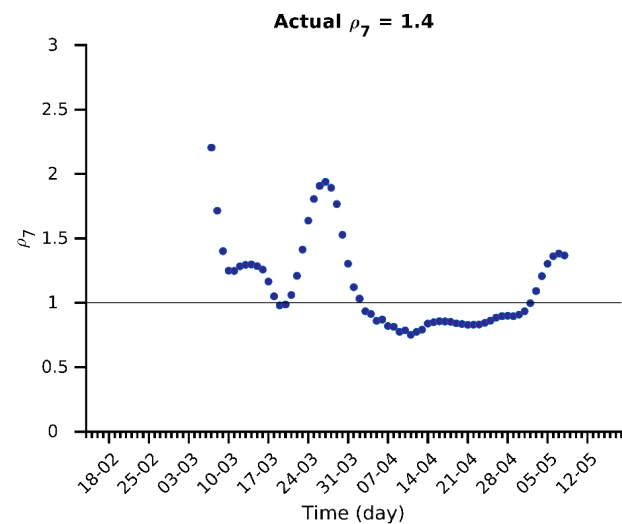
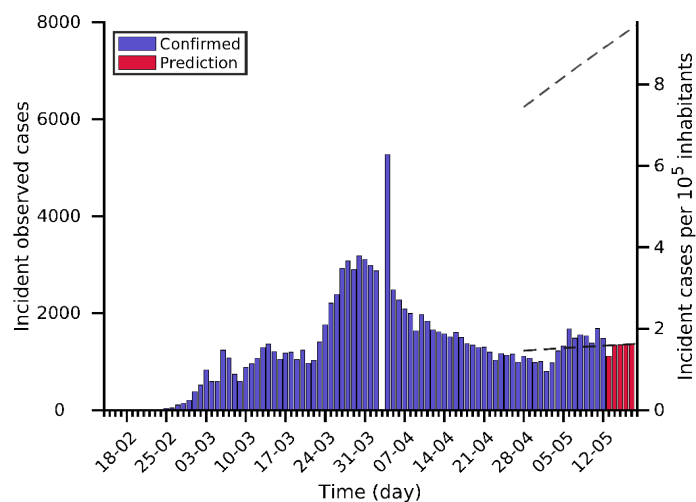
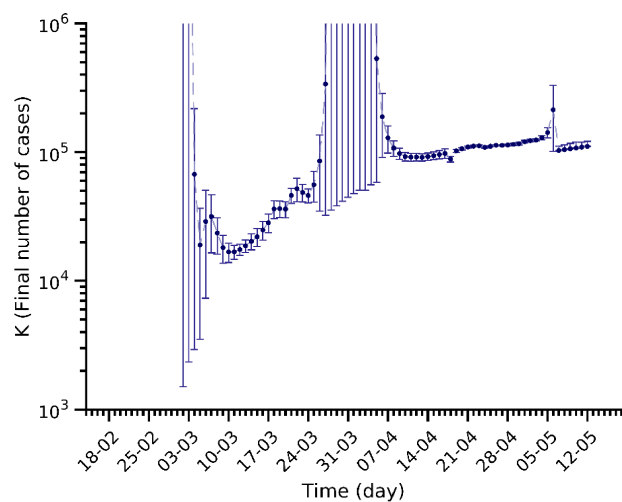
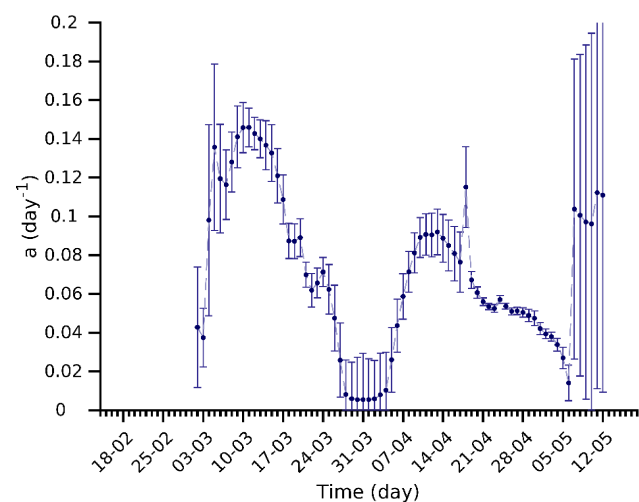
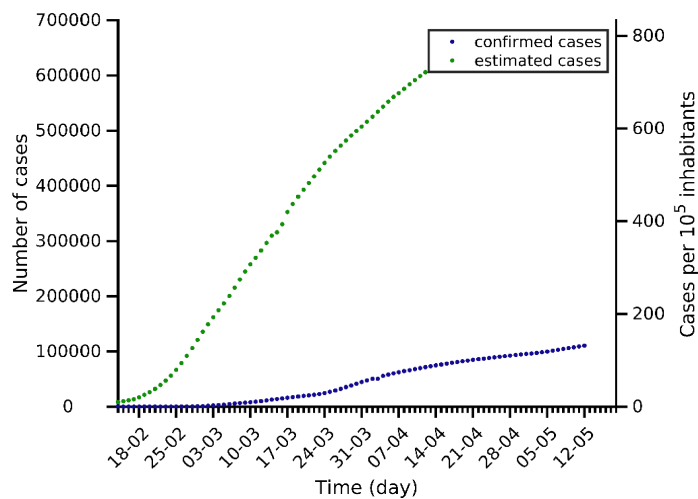
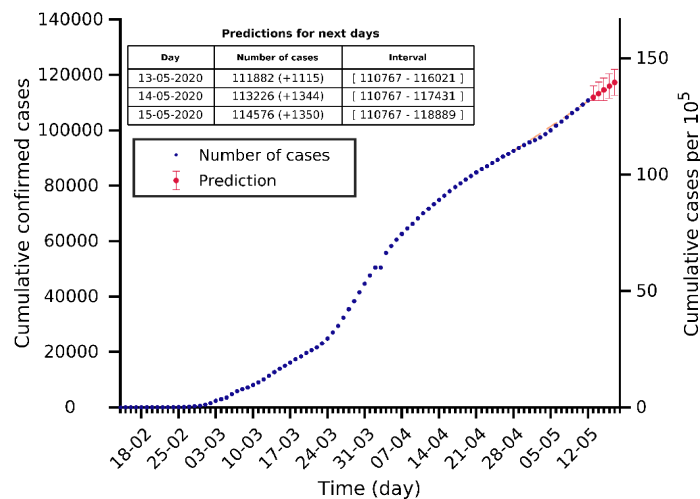
Turkey 12-05-2020. Population: 84.3M. Current cumulated incidence: 168/10⁵



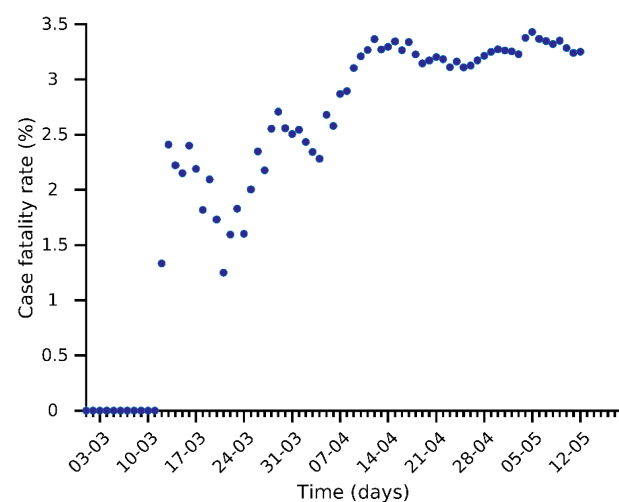
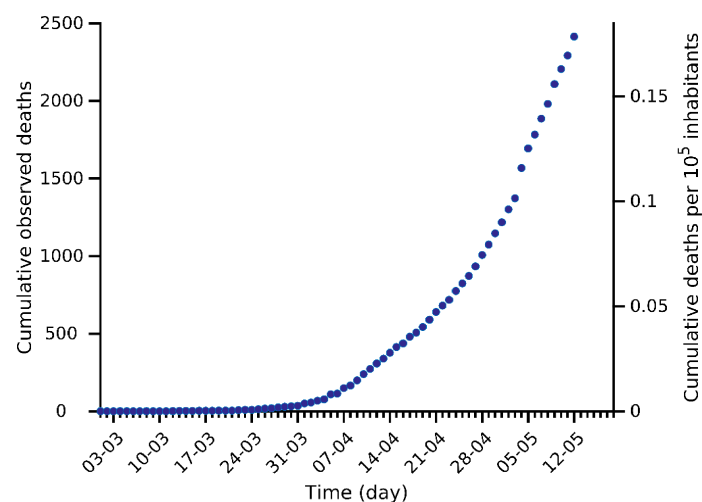
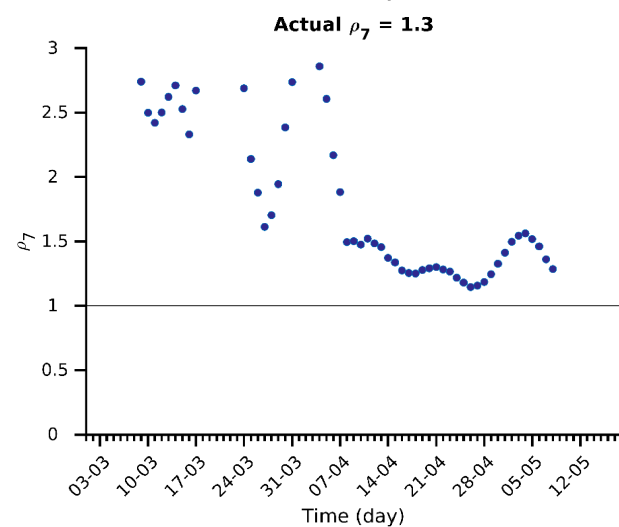
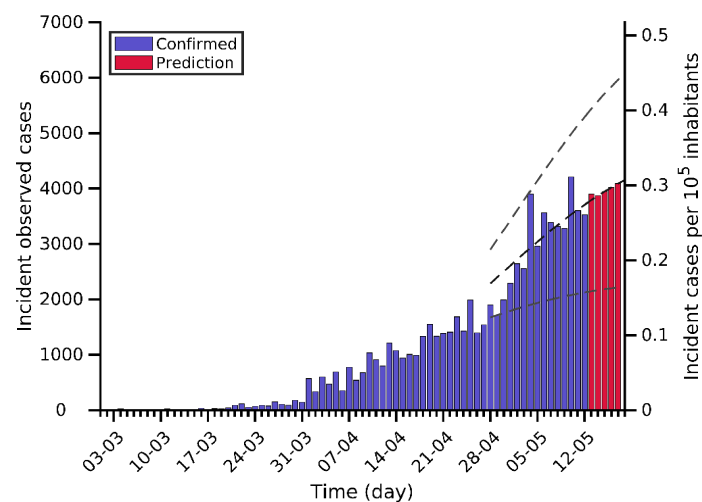
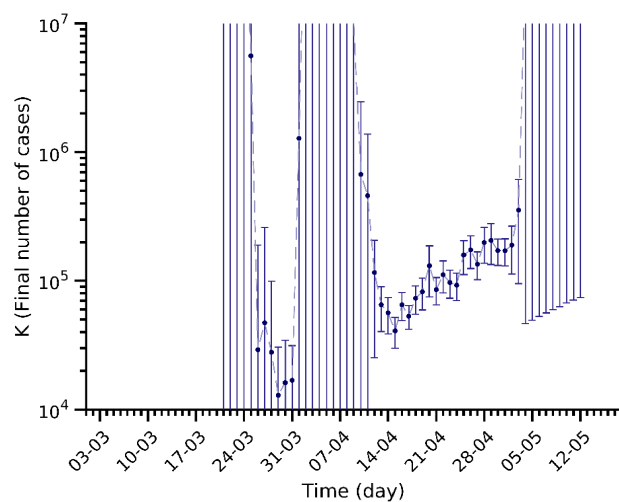
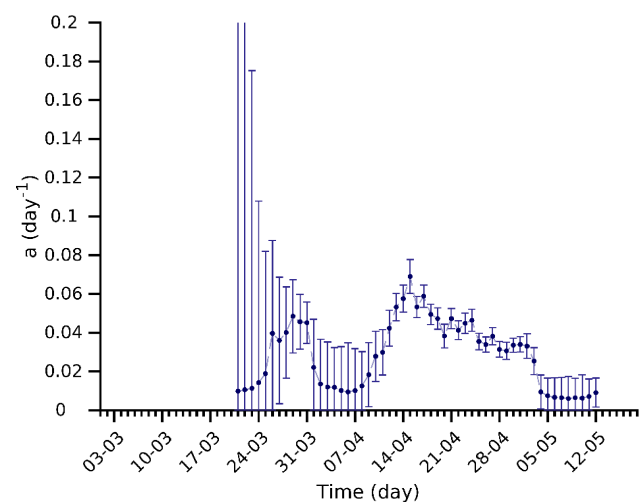
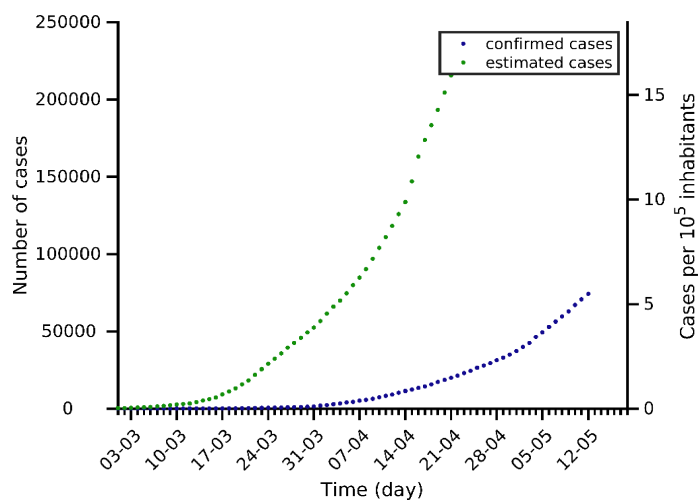
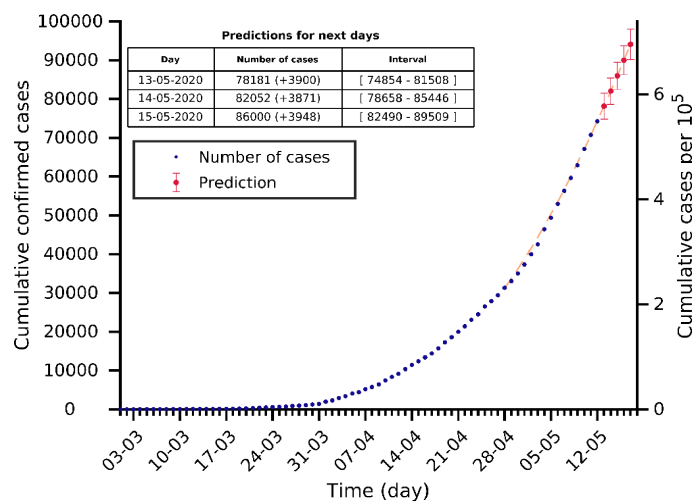
USA 12-05-2020. Population: 331.0M. Current cumulated incidence: 414/10⁵



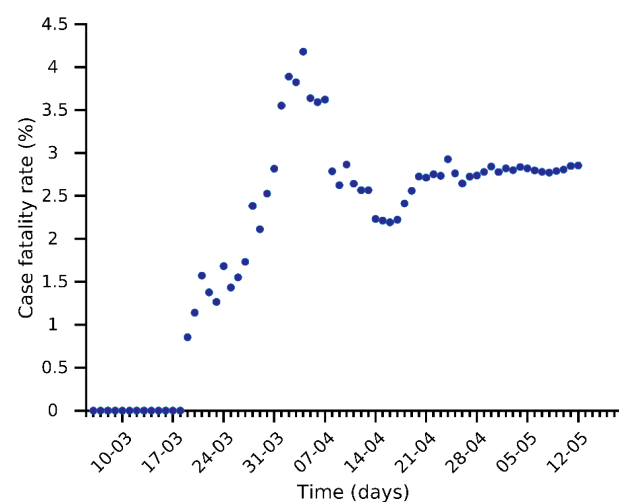
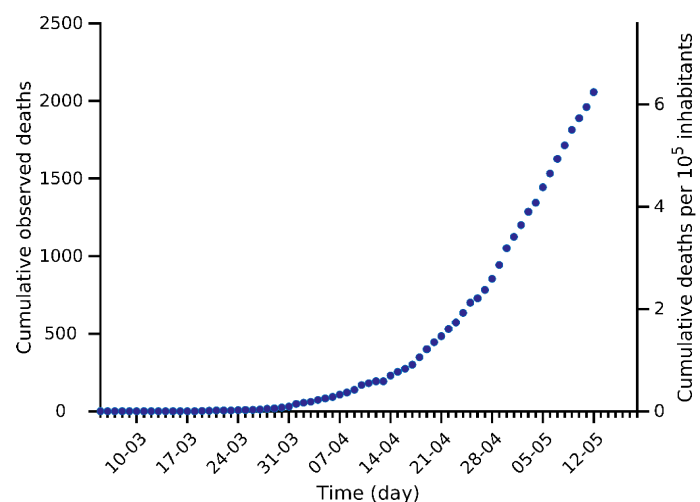
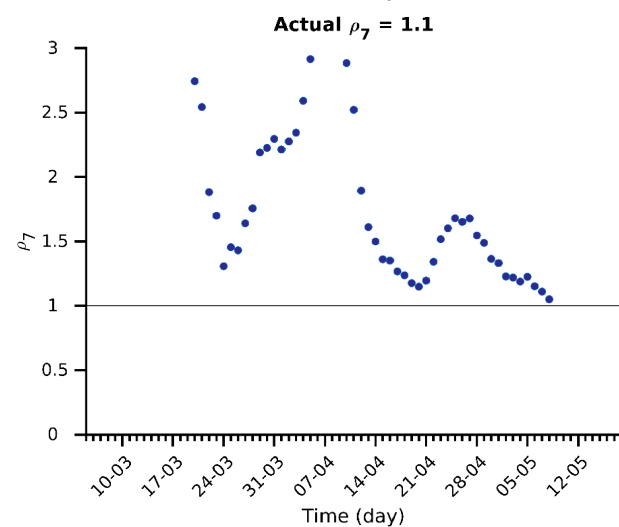
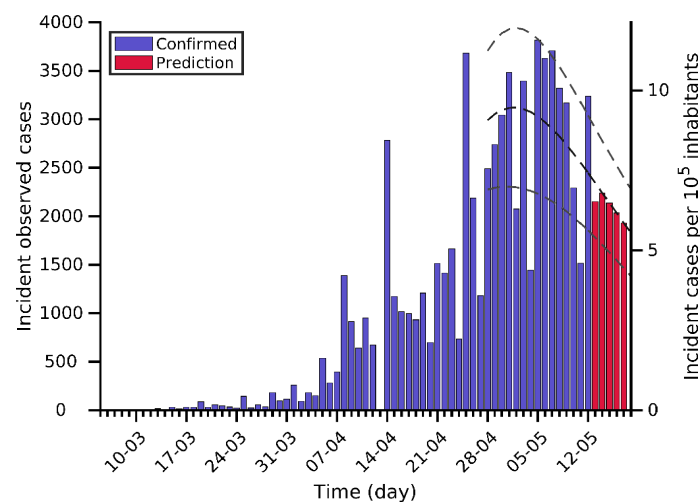
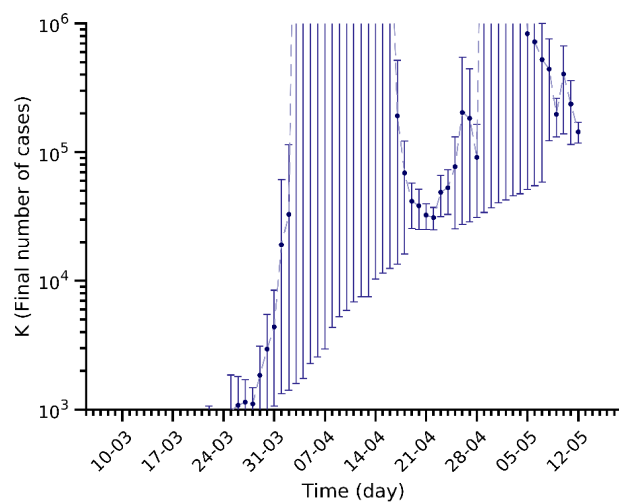
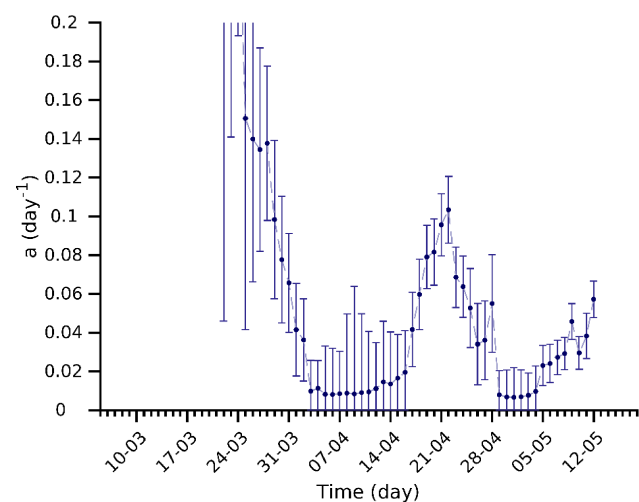
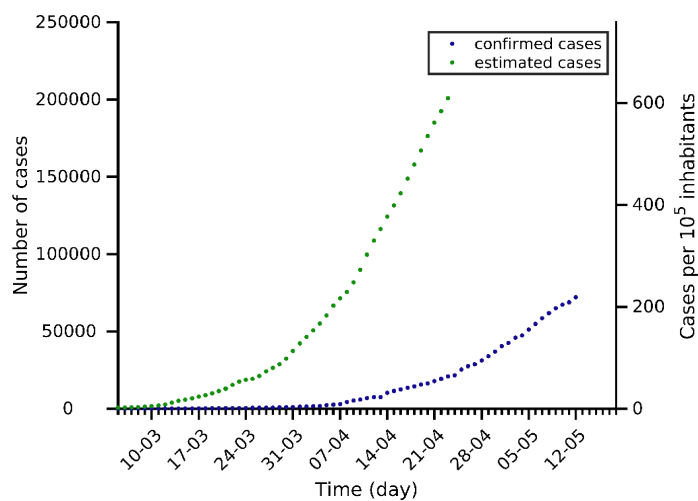
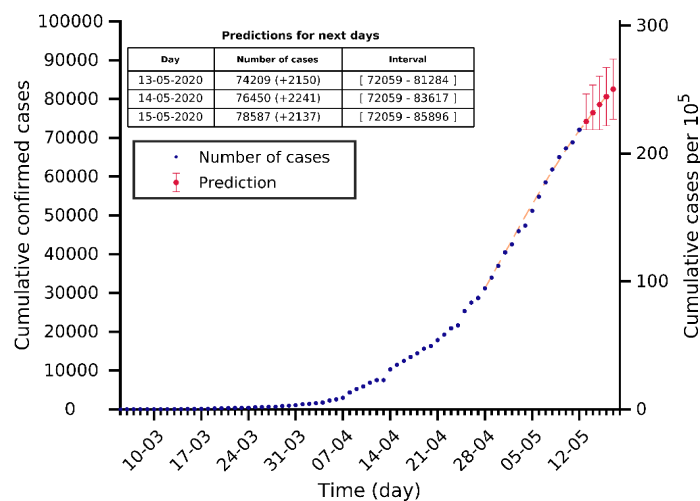
Iran 12-05-2020. Population: 84.0M. Current cumulated incidence: 132/10⁵



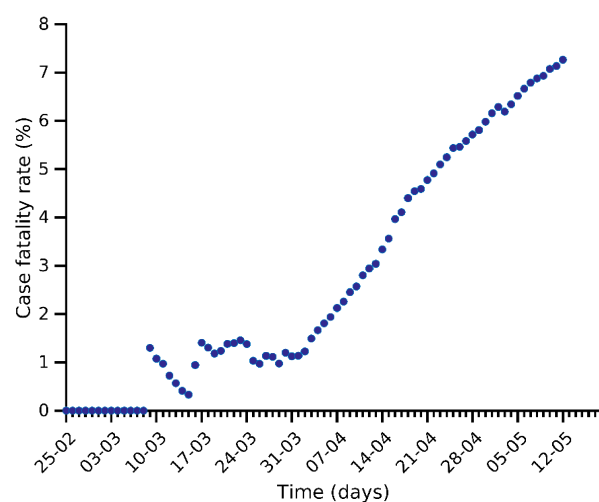
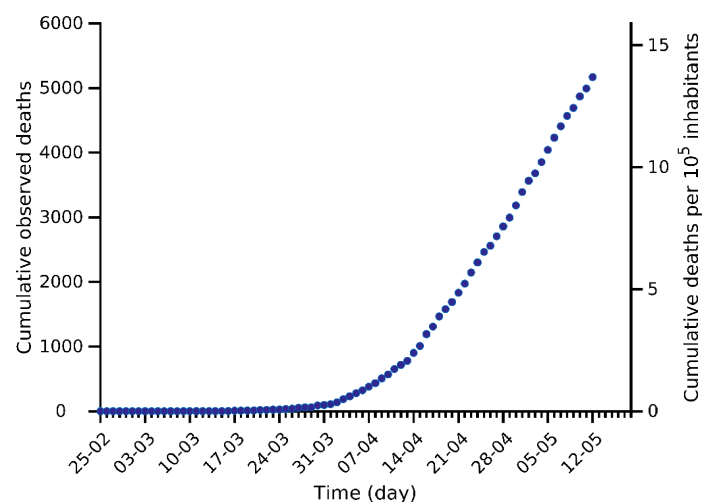
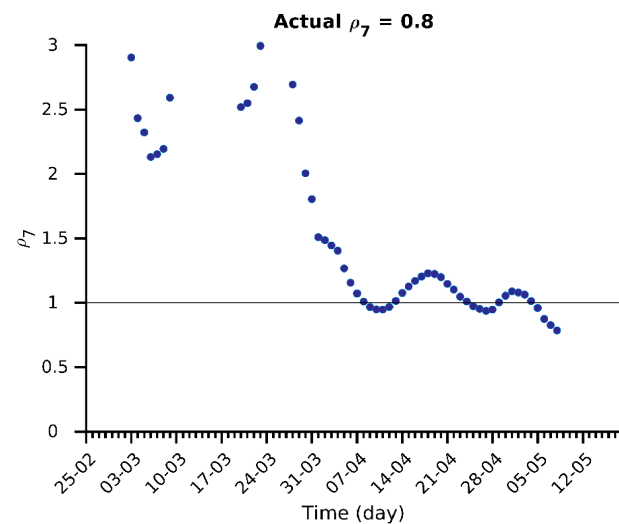
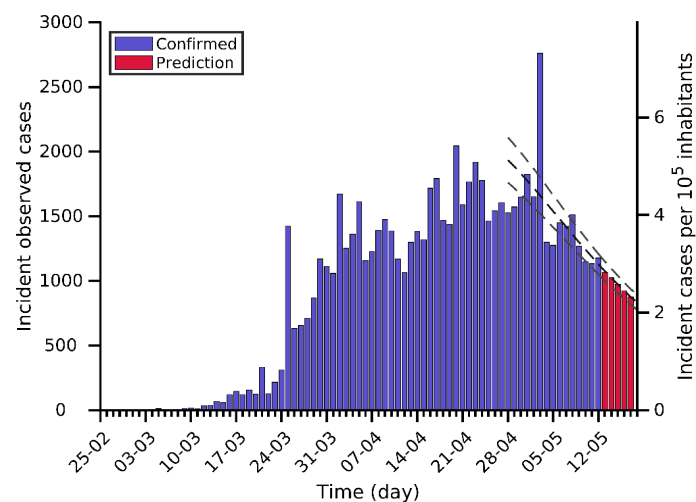
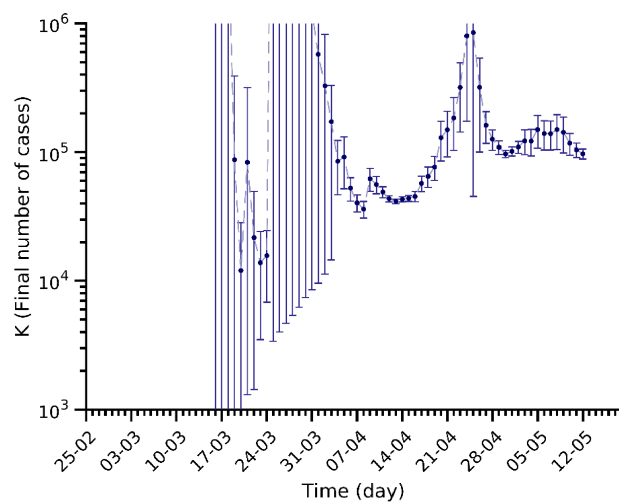
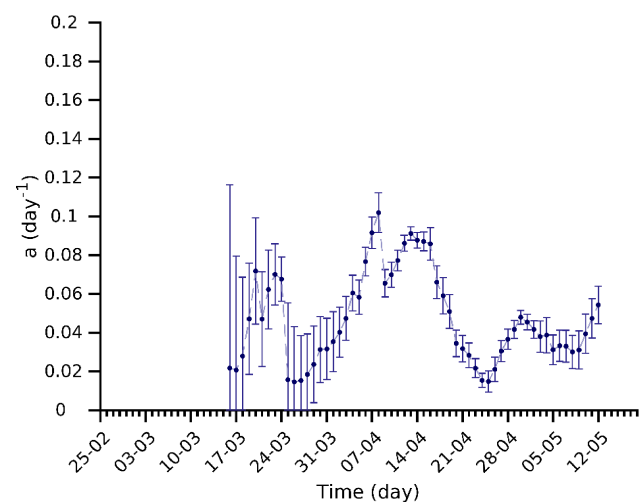
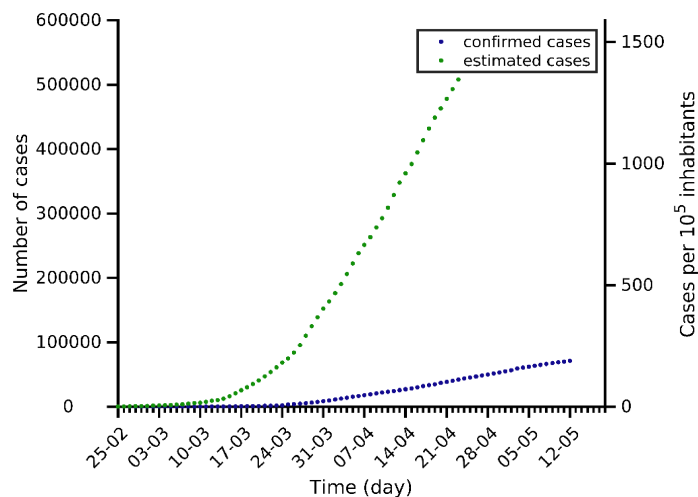
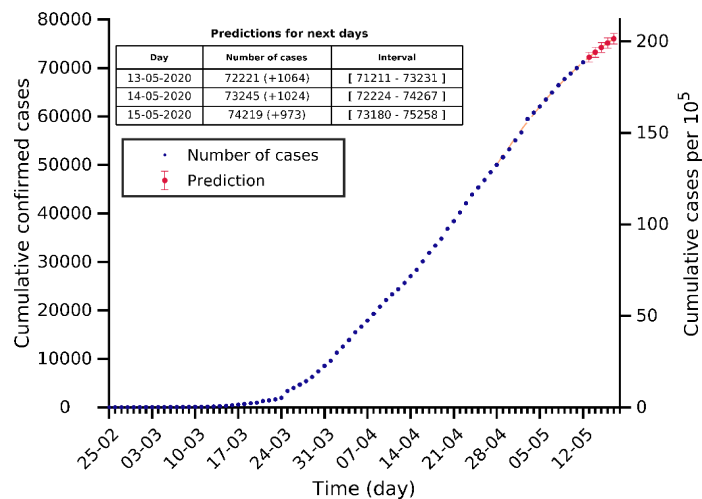
India 12-05-2020. Population: 1353.0M. Current cumulated incidence: 5/10⁵



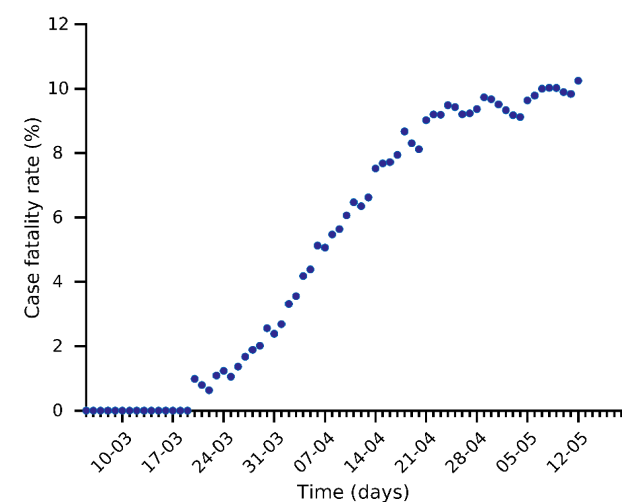
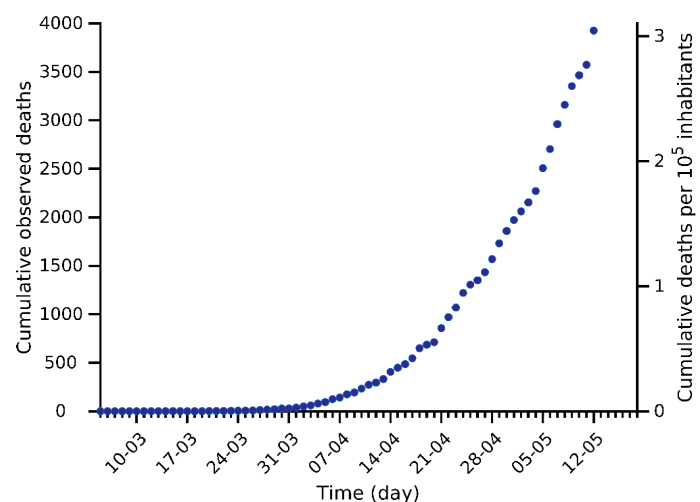
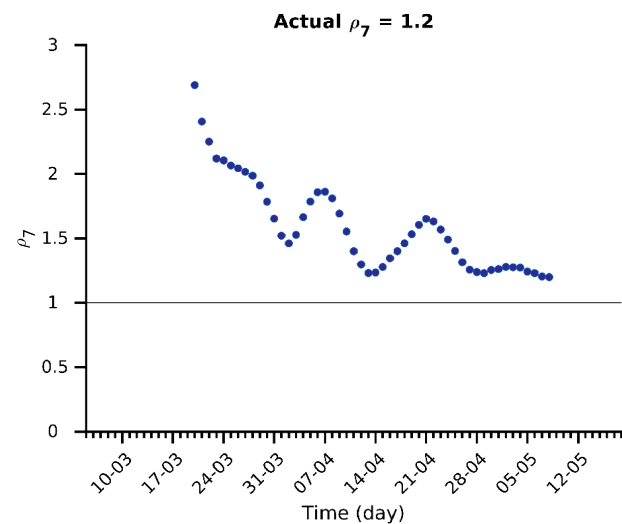
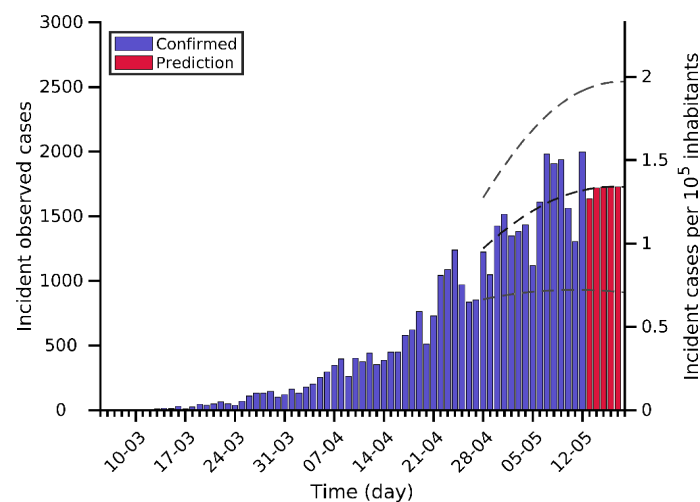
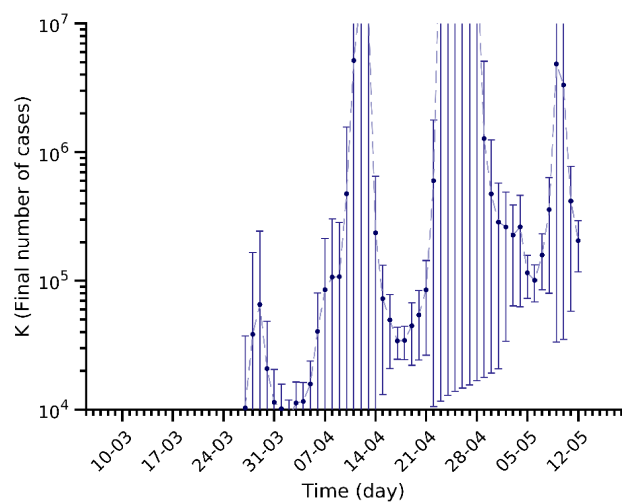
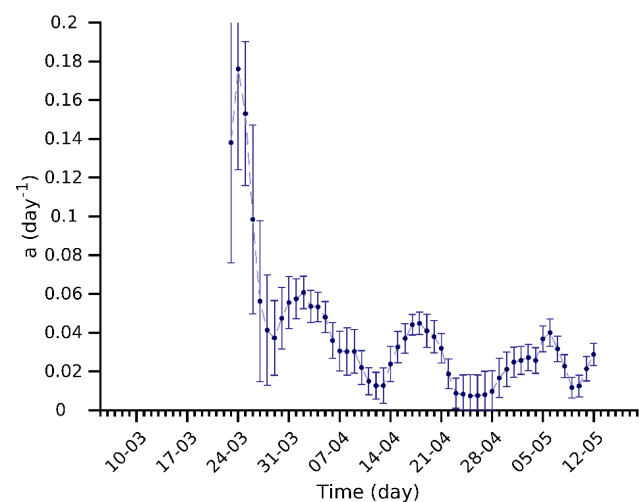
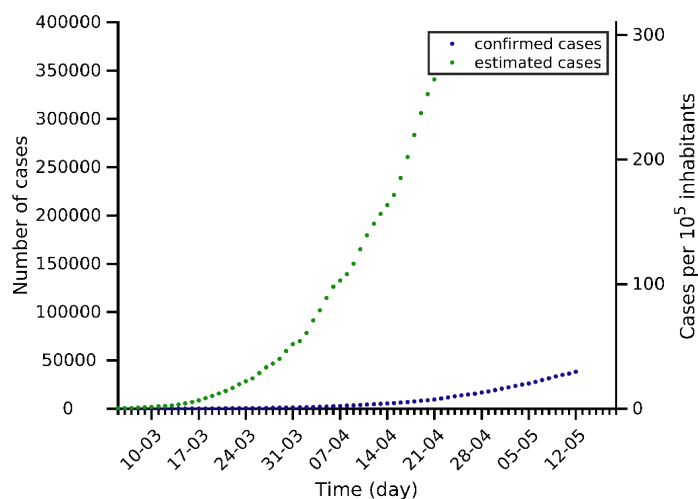
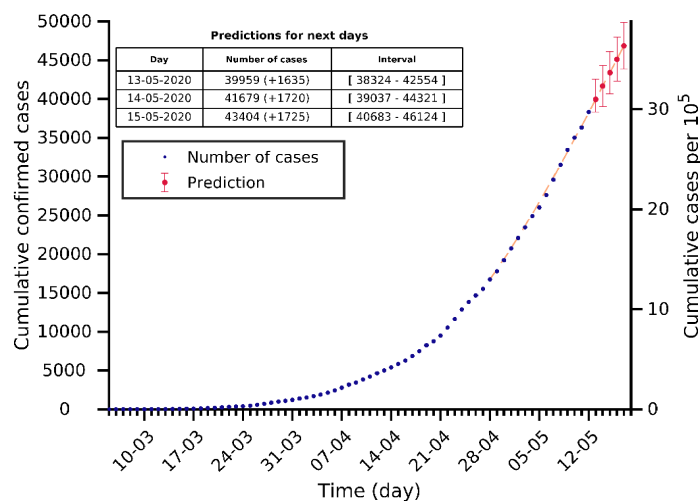
Peru 12-05-2020. Population: 33.0M. Current cumulated incidence: 219/10⁵



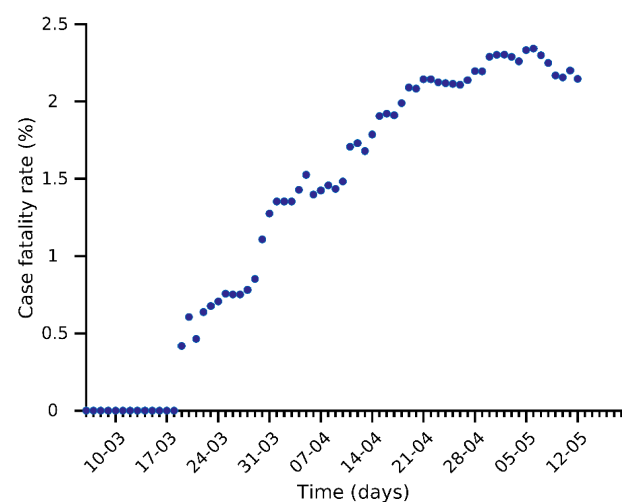
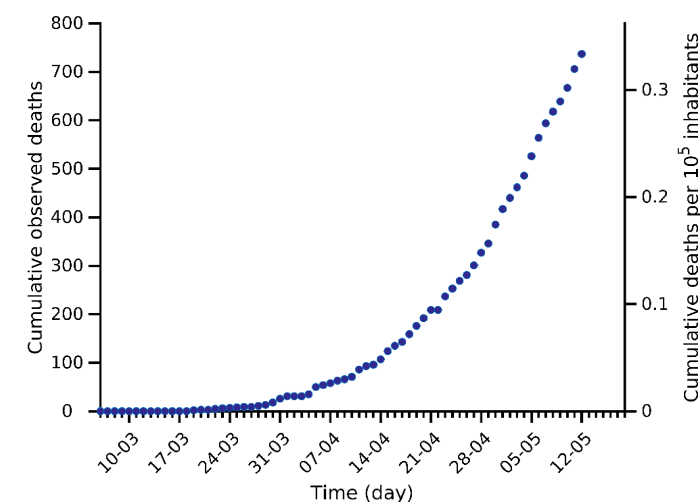
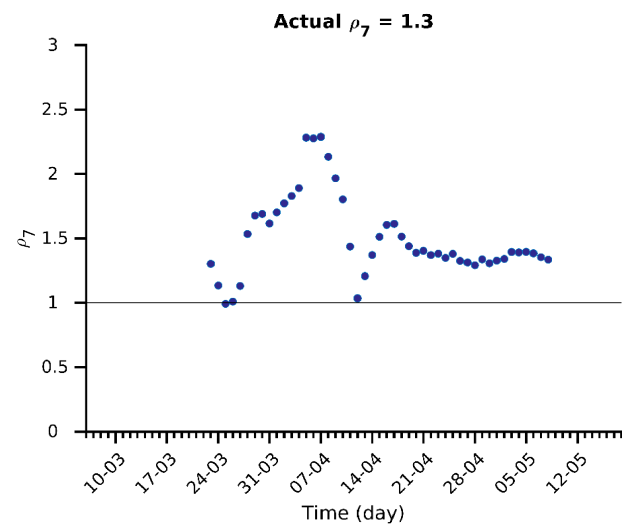
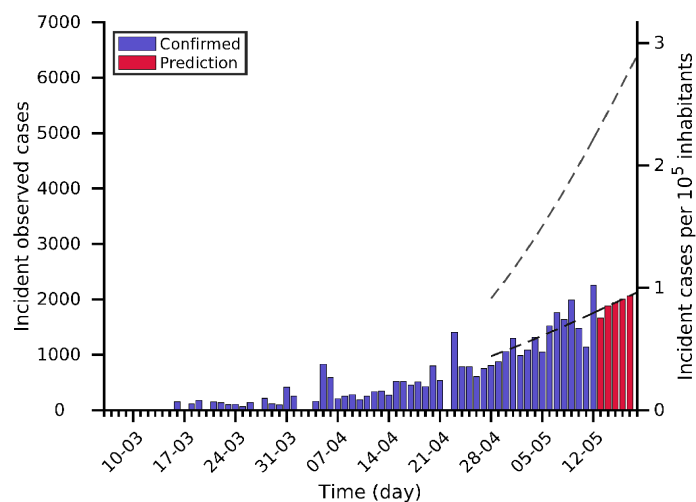
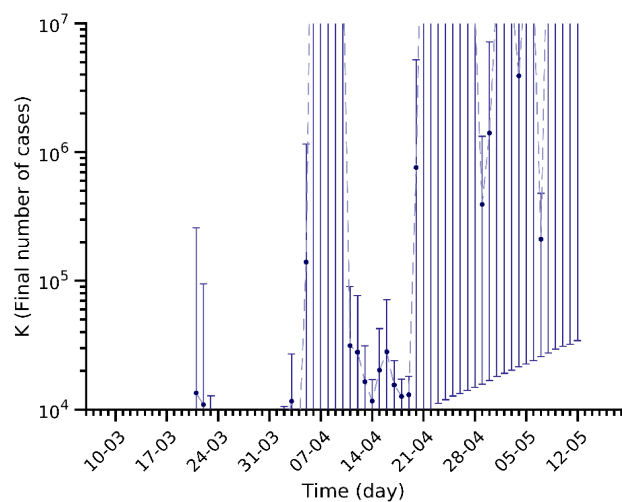
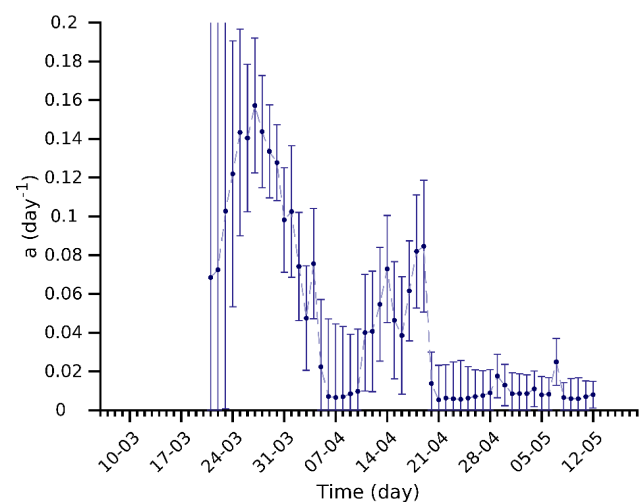
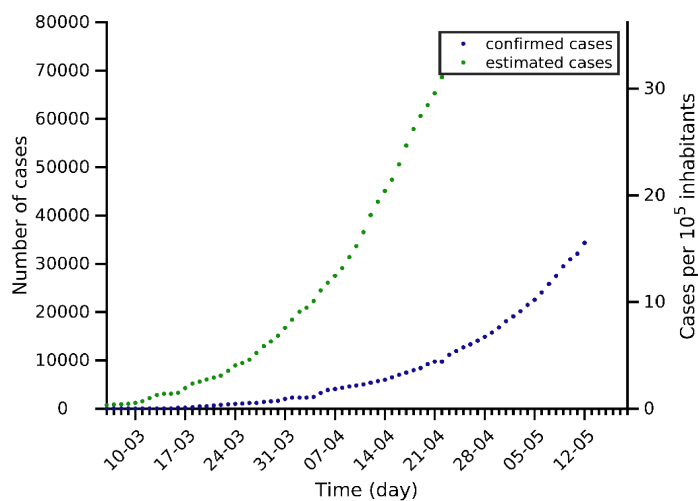
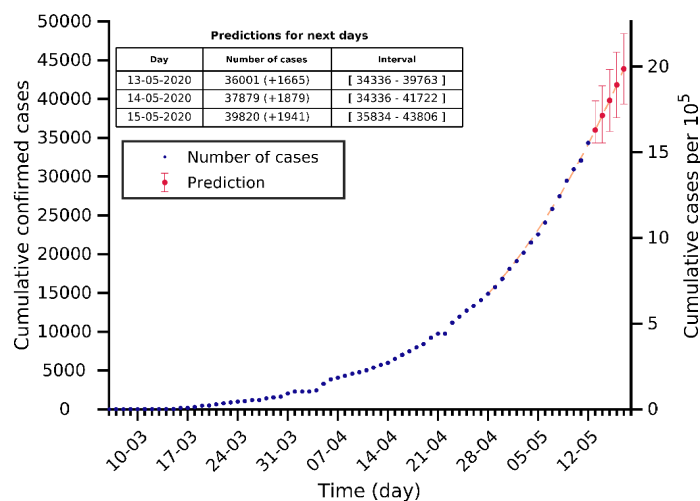
Canada 12-05-2020. Population: 37.7M. Current cumulated incidence: 189/10⁵



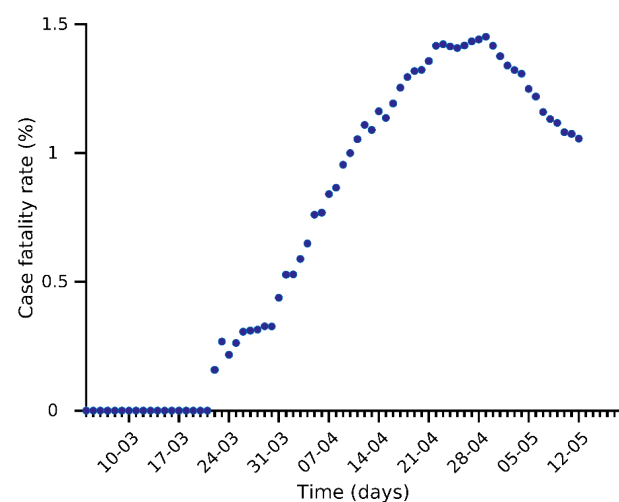
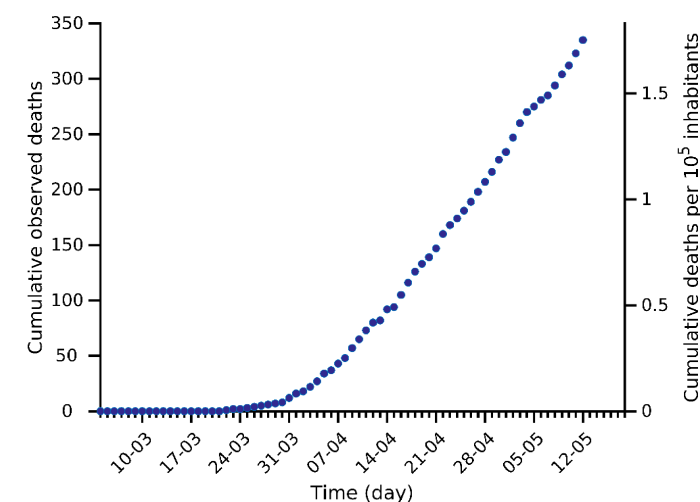
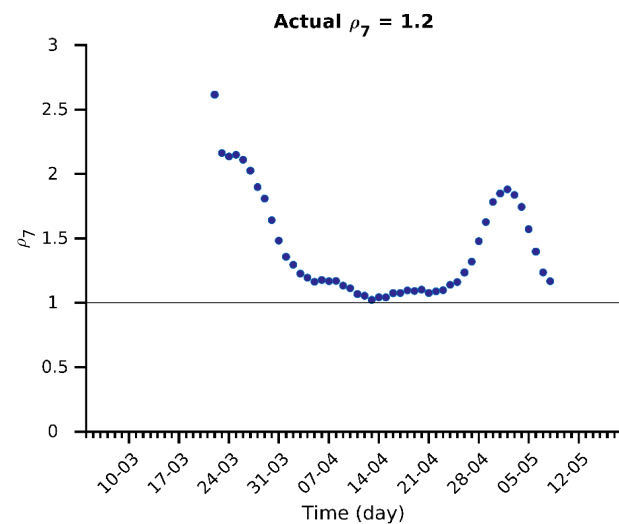
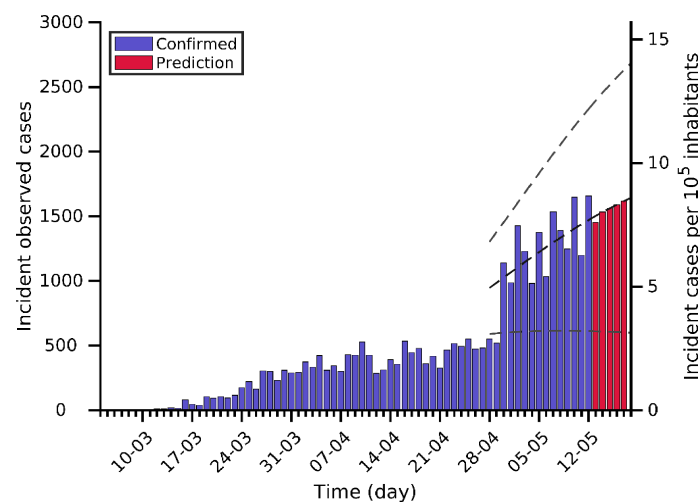
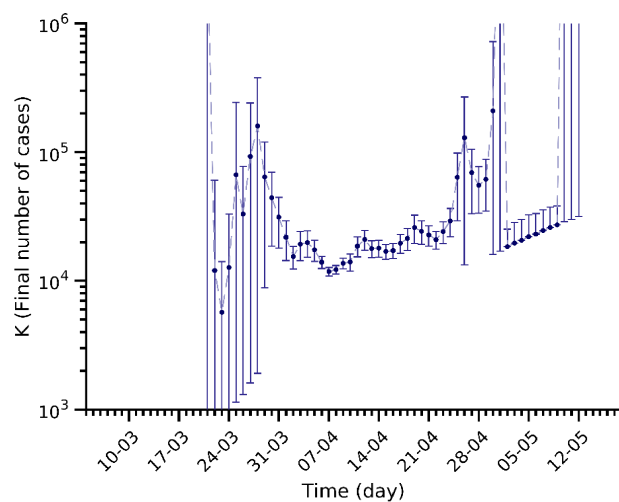
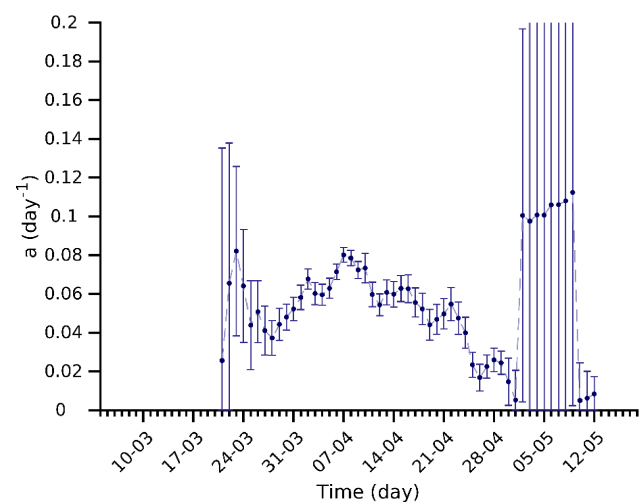
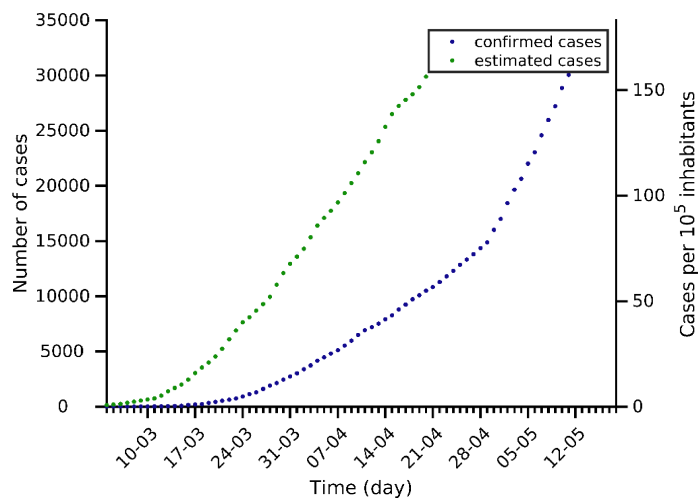
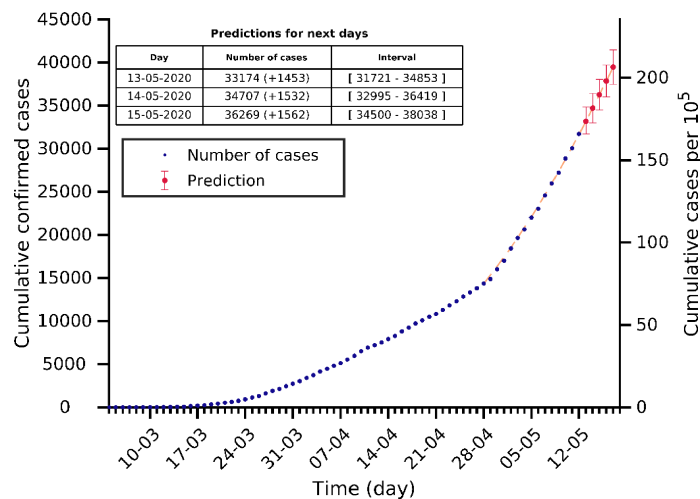
Mexico 12-05-2020. Population: 128.9M. Current cumulated incidence: 30/10⁵



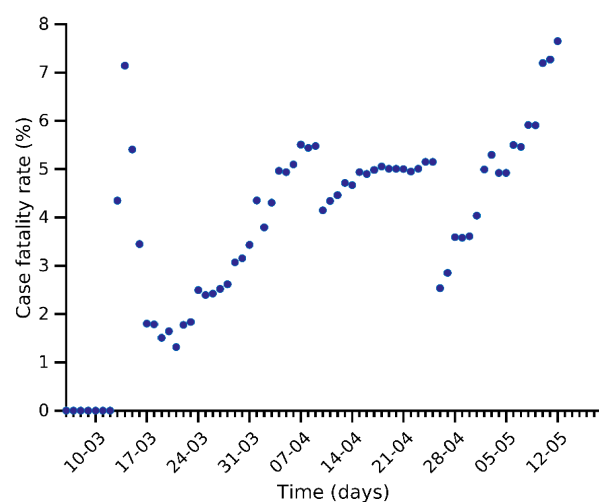
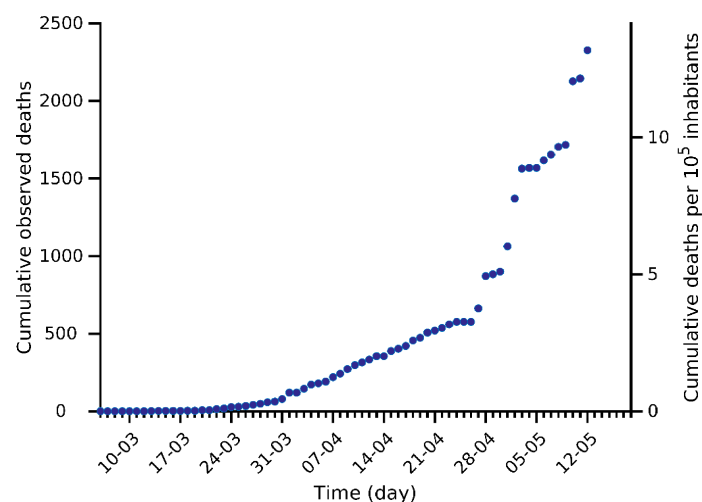
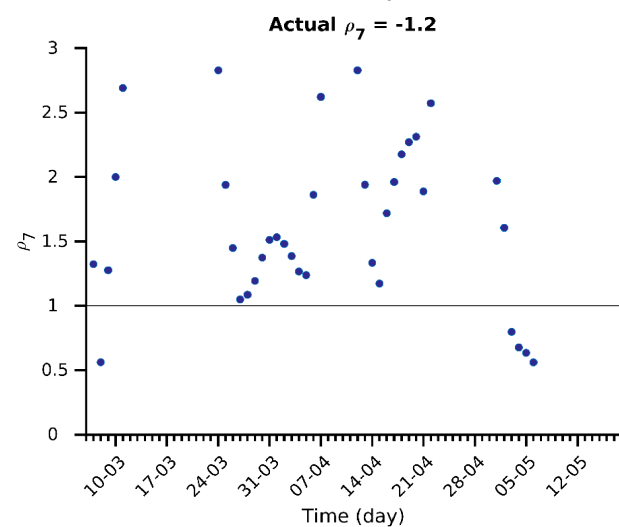
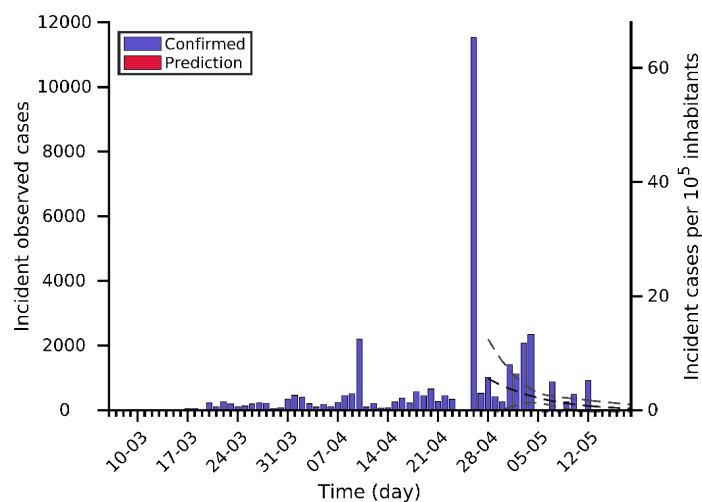
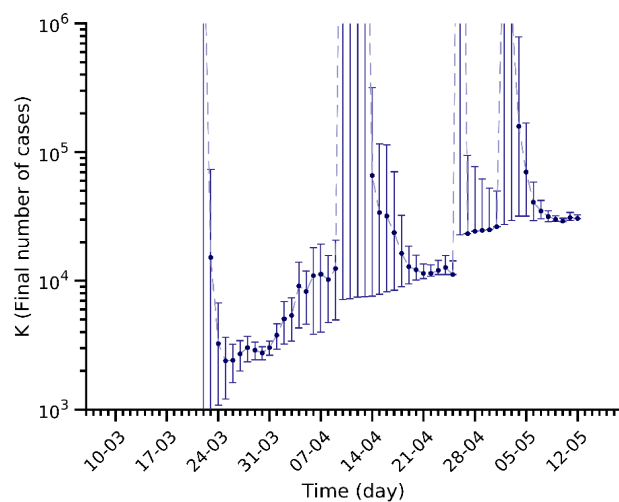
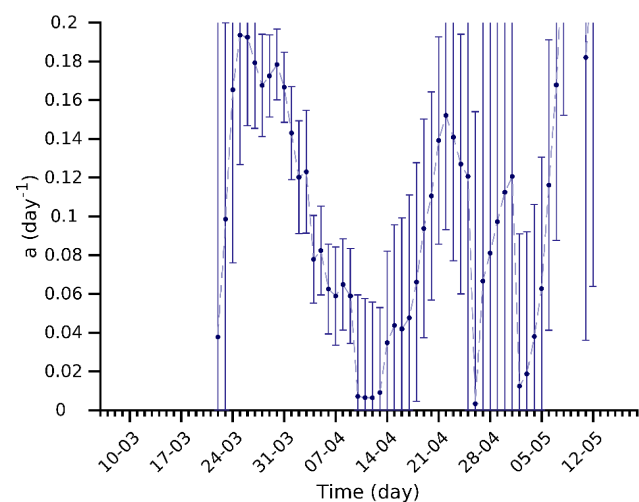
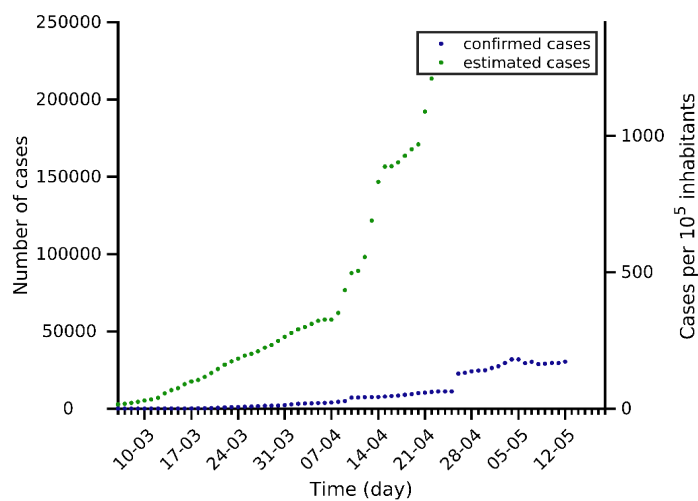
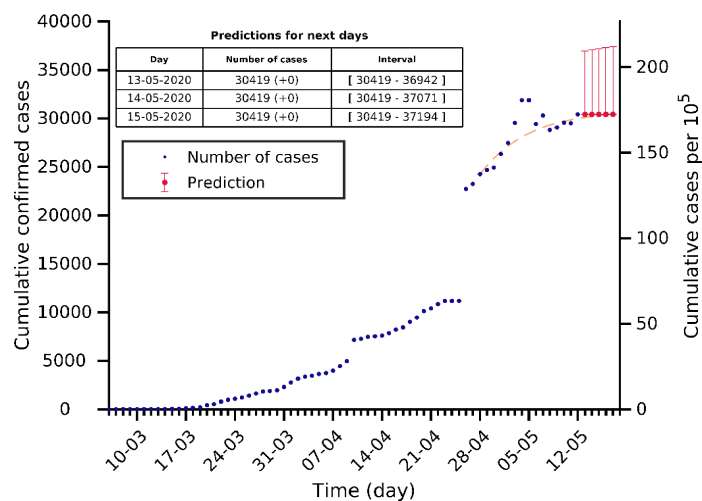
Pakistan 12-05-2020. Population: 220.9M. Current cumulated incidence: 16/10⁵



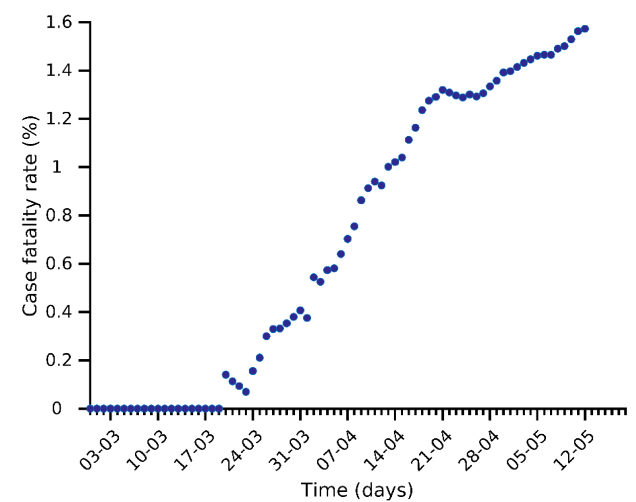
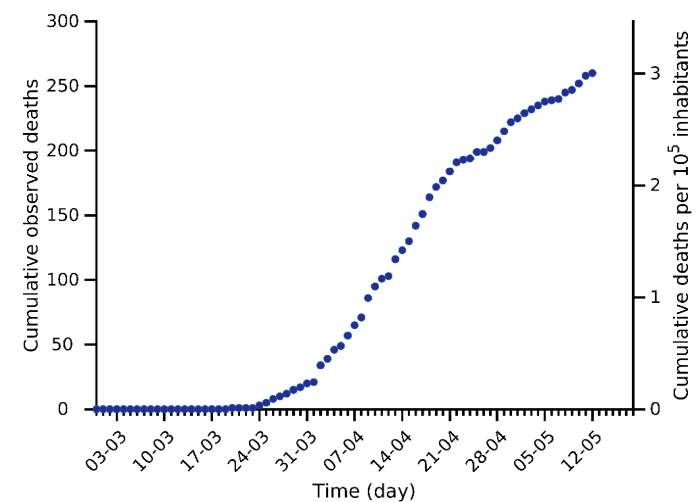
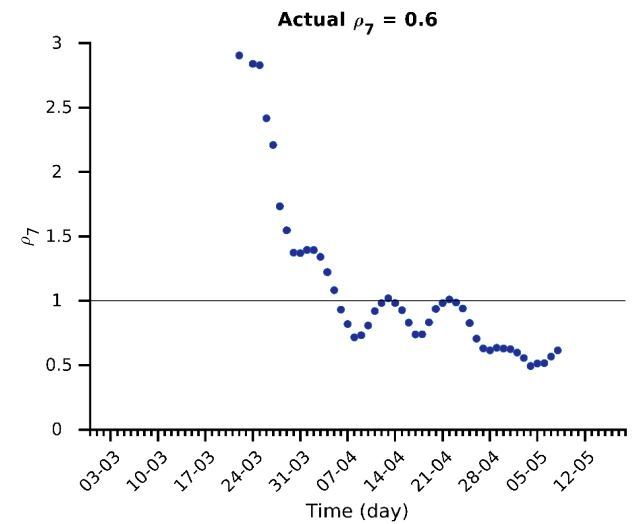
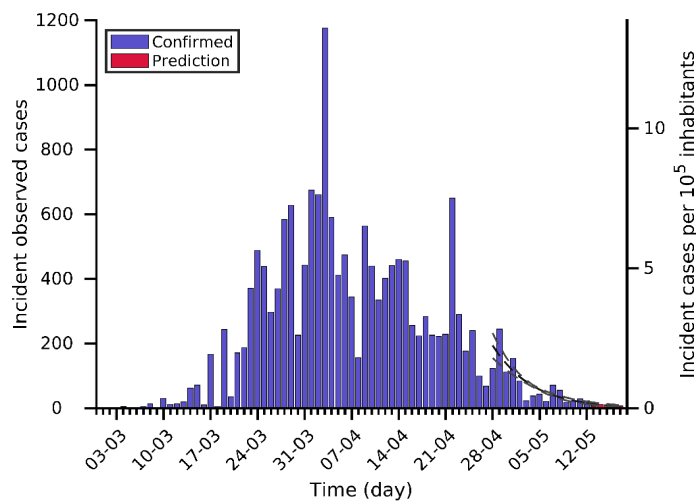
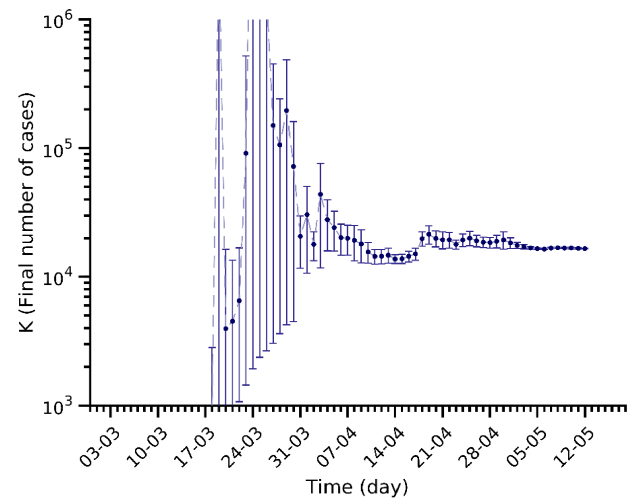
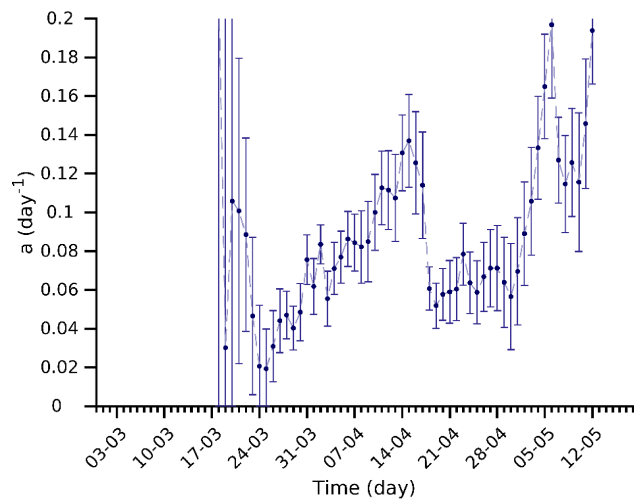
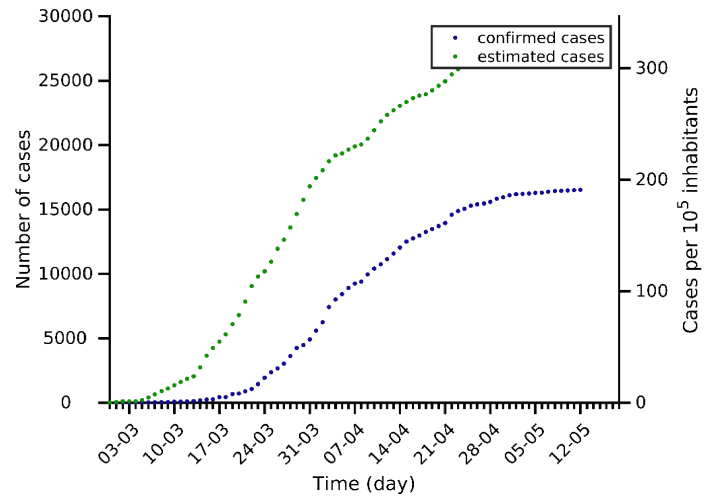
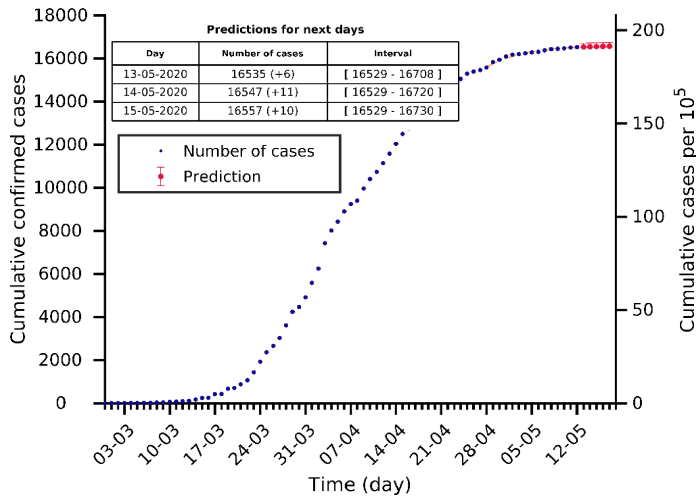
Chile 12-05-2020. Population: 19.1M. Current cumulated incidence: 166/10⁵



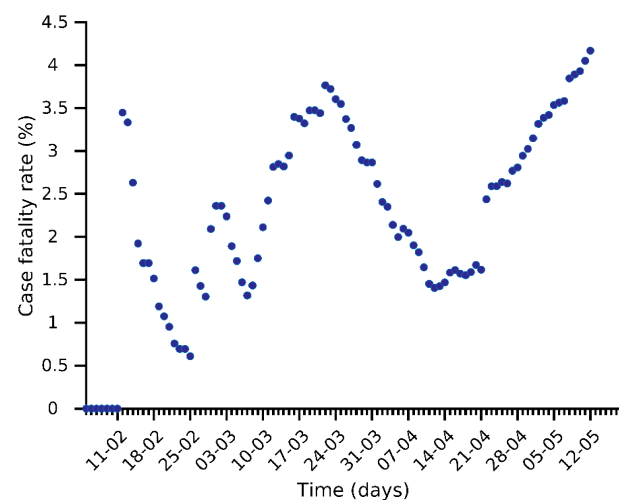
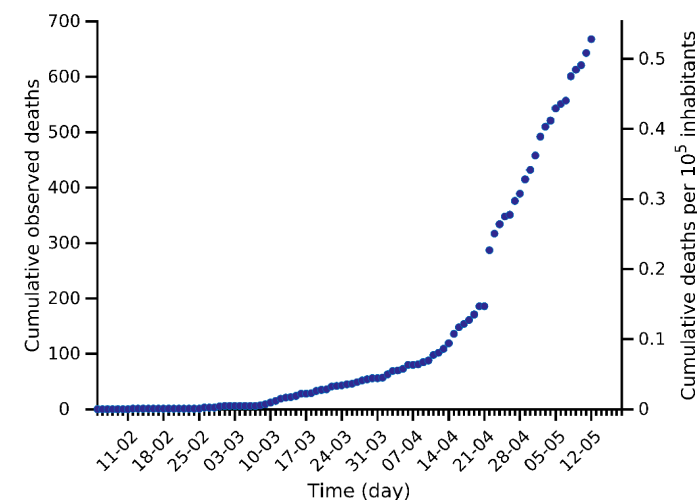
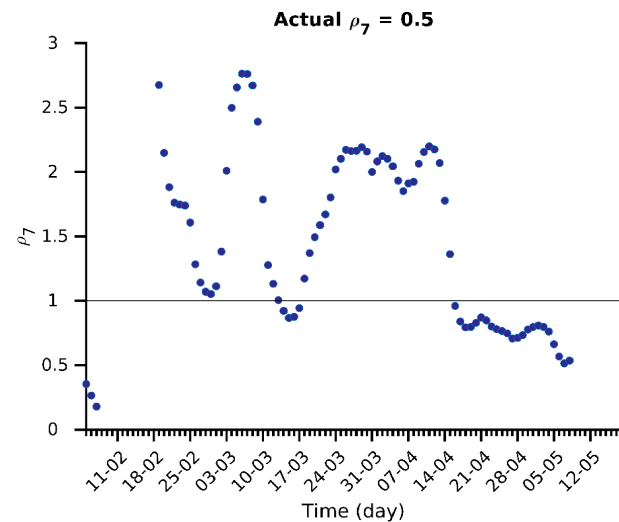
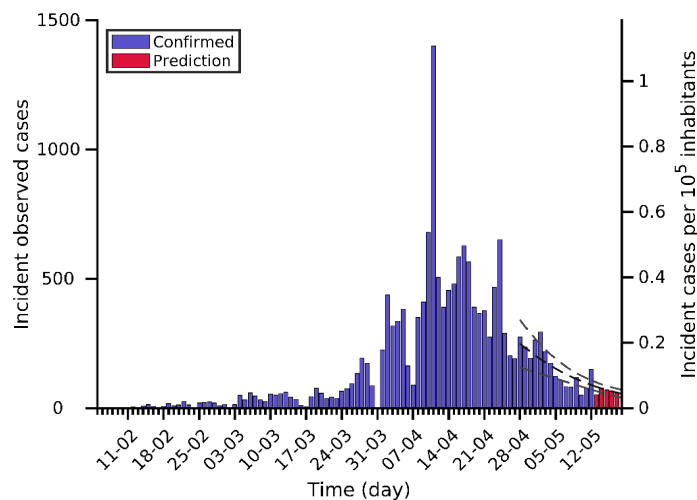
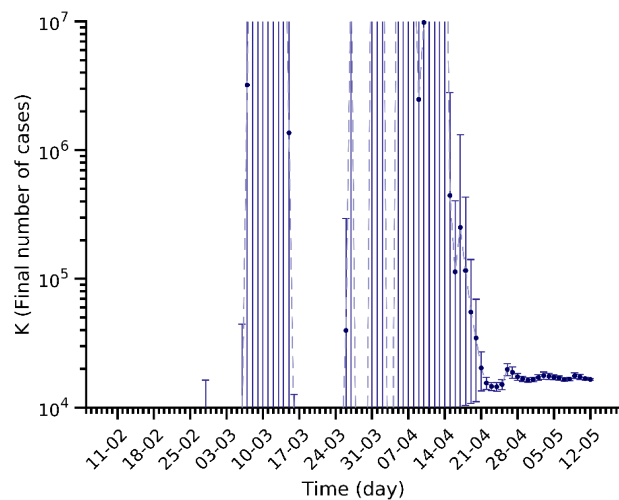
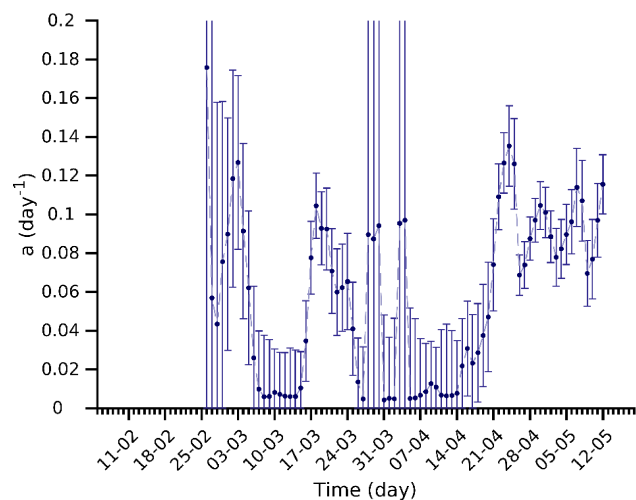
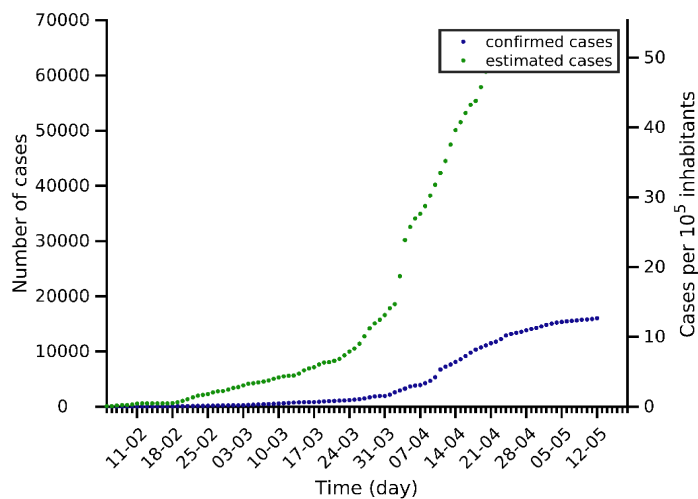
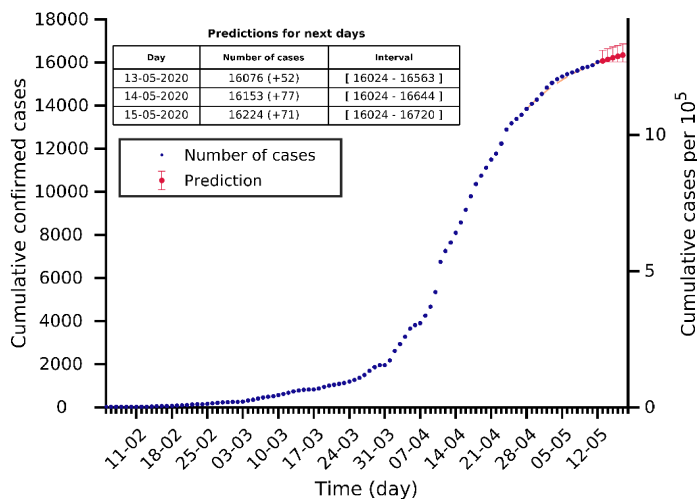
Ecuador 12-05-2020. Population: 17.6M. Current cumulated incidence: 172/10⁵



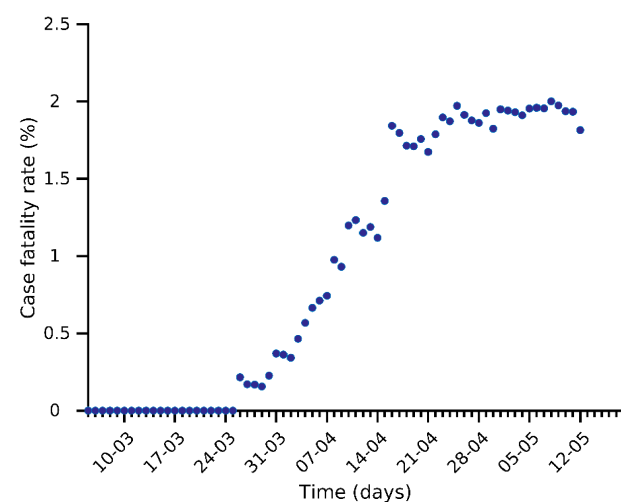
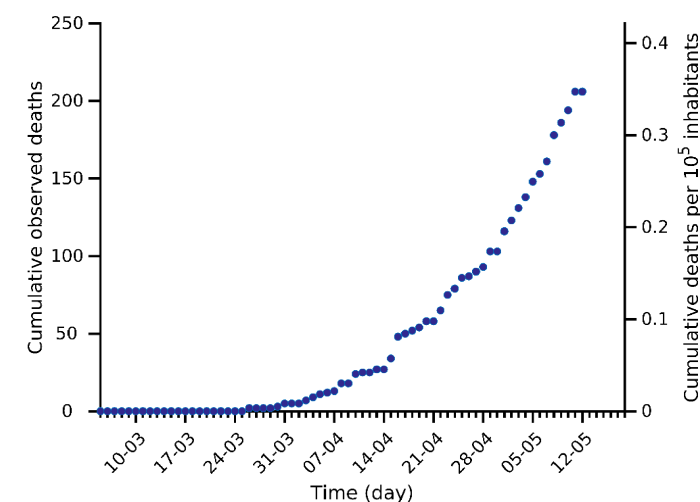
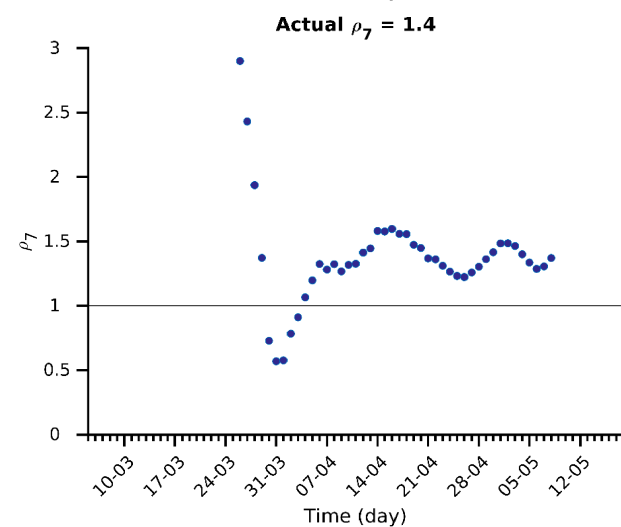
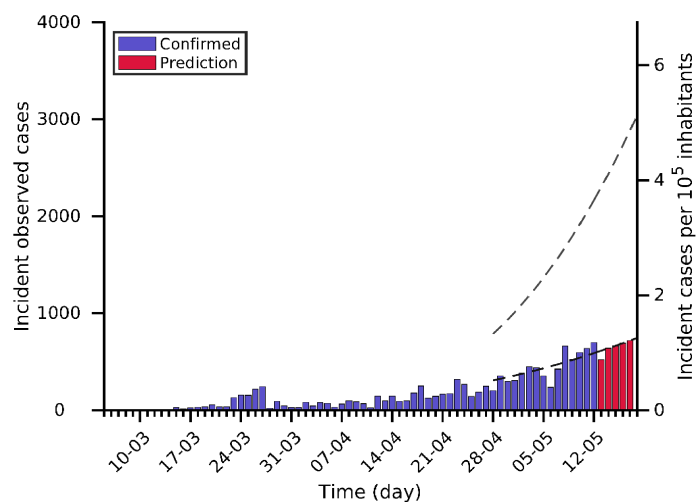
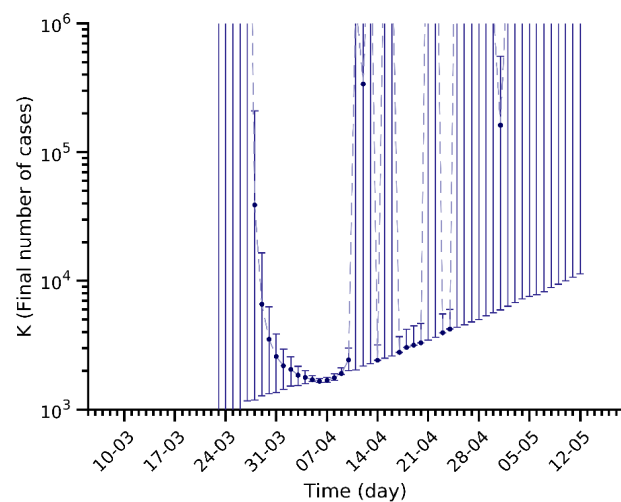
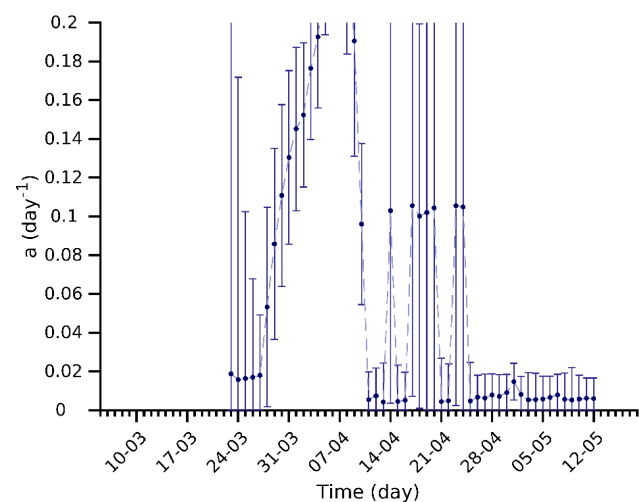
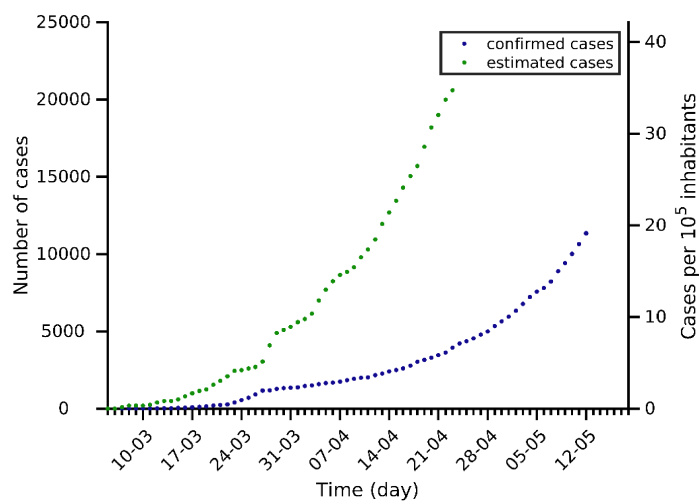
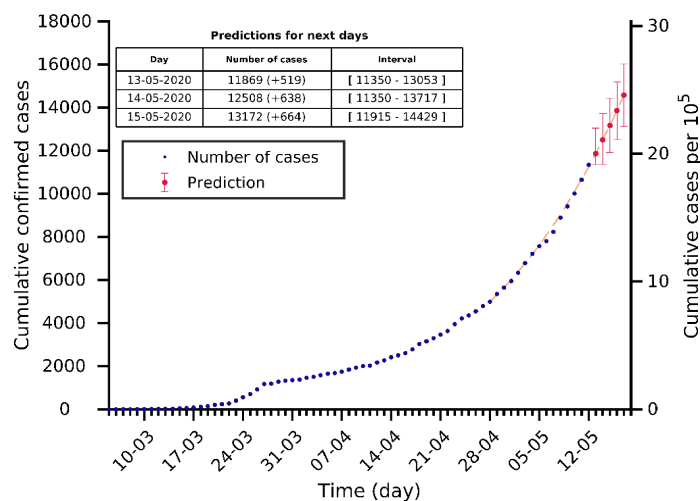
Israel 12-05-2020. Population: 8.7M. Current cumulated incidence: 191/10⁵



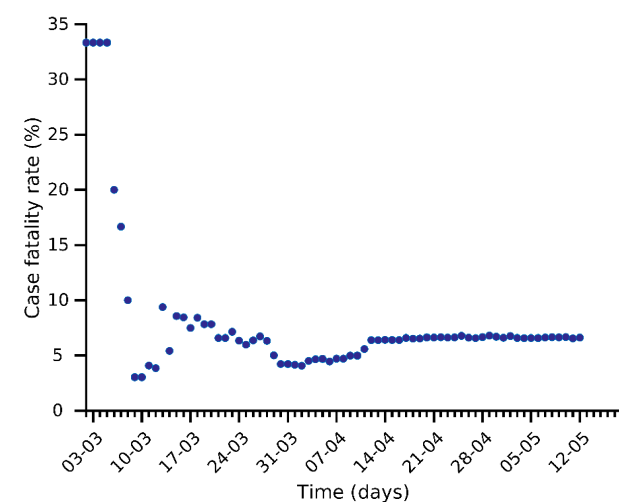
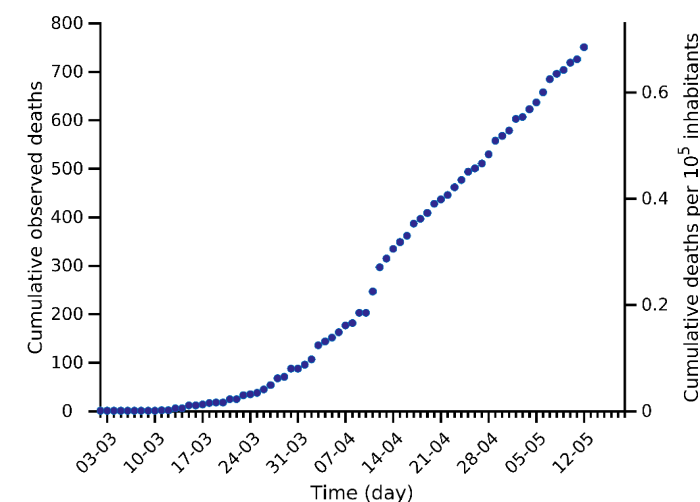
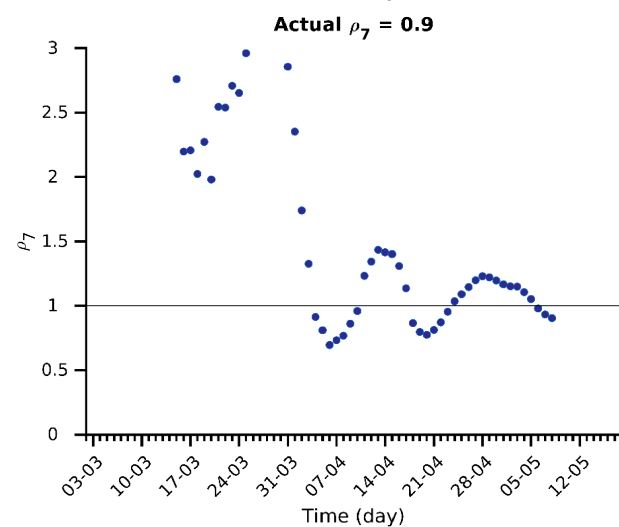
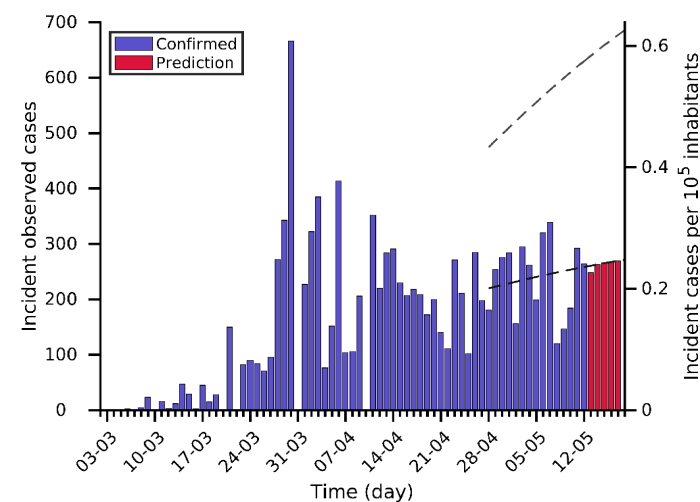
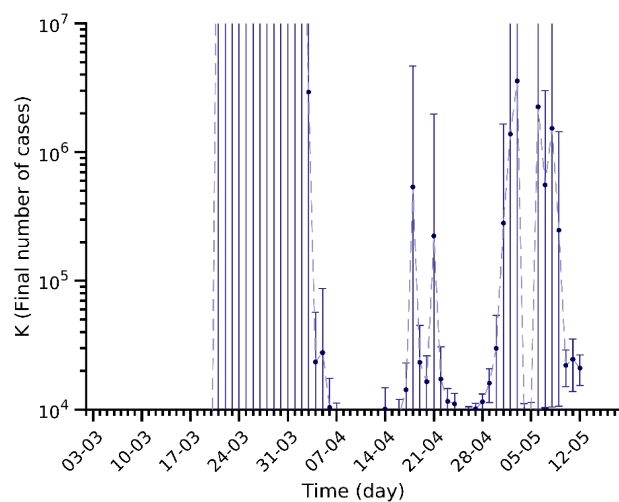
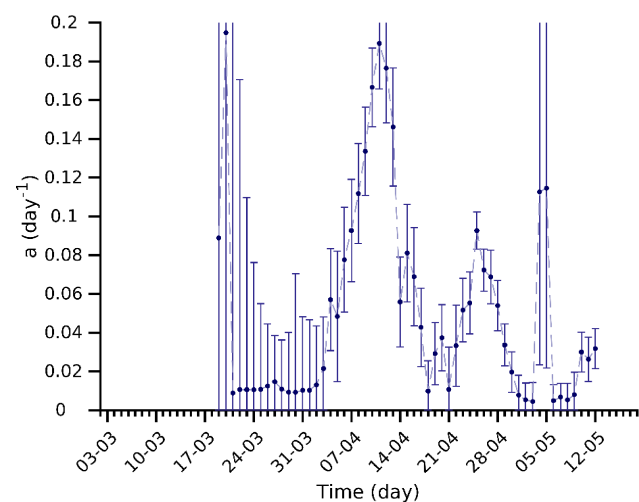
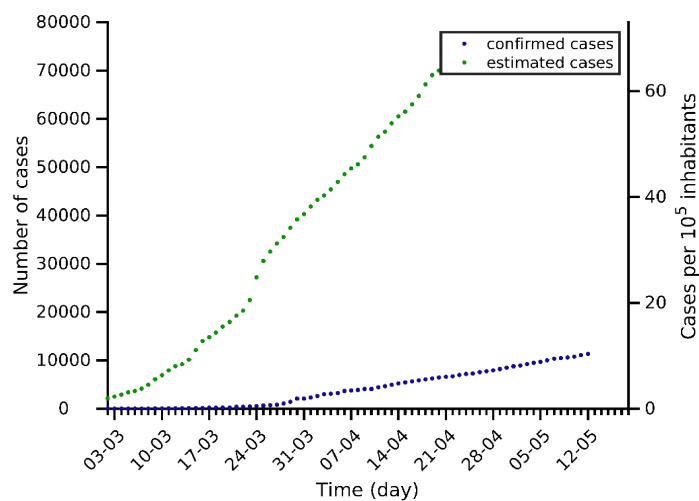
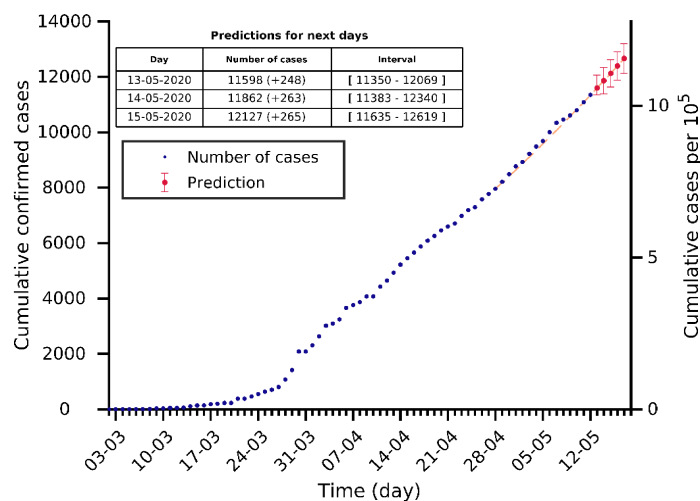
Japan 12-05-2020. Population: 126.5M. Current cumulated incidence: 13/10⁵



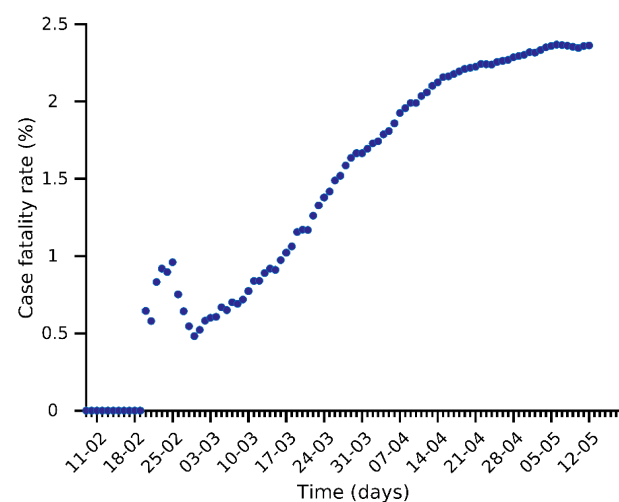
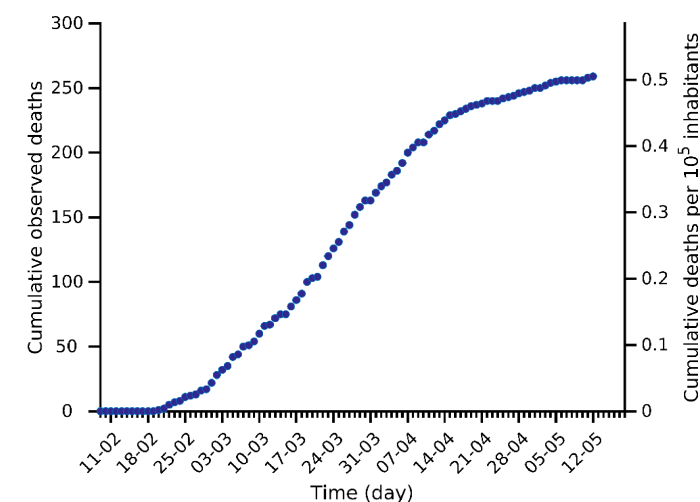
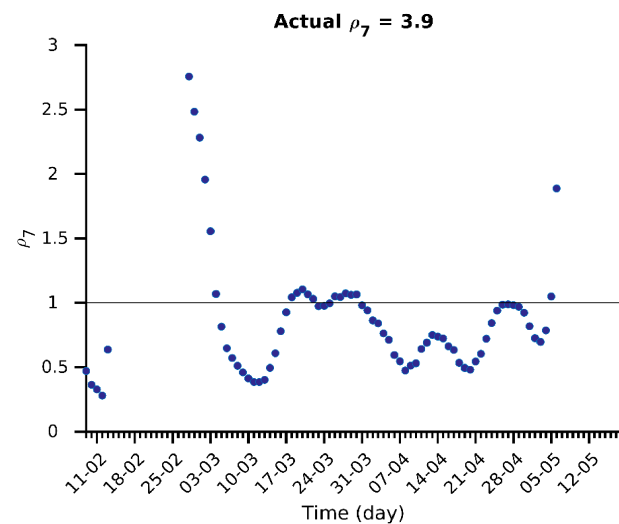
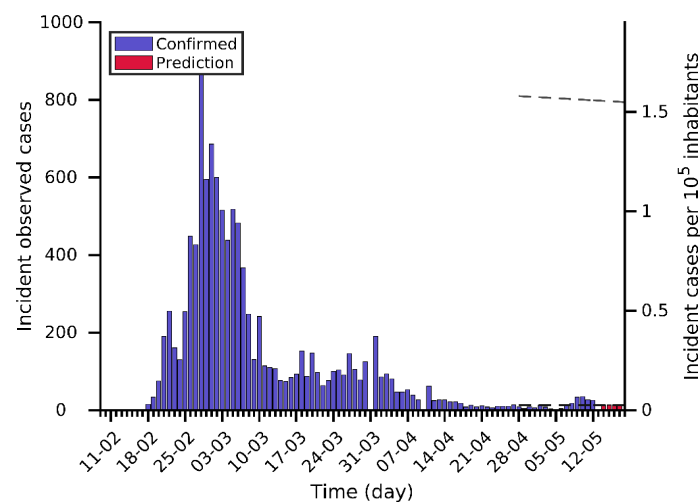
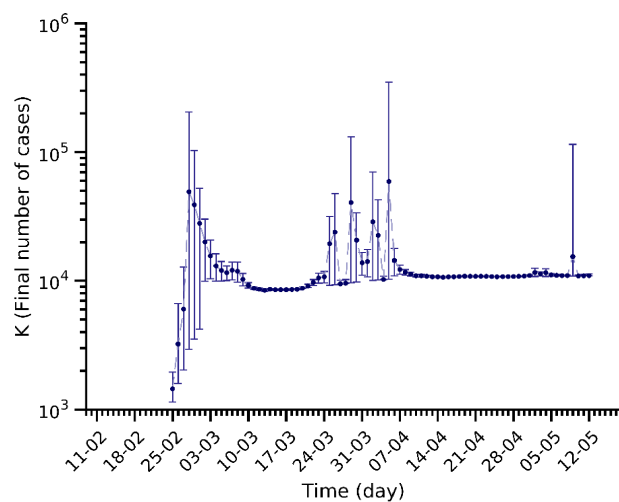
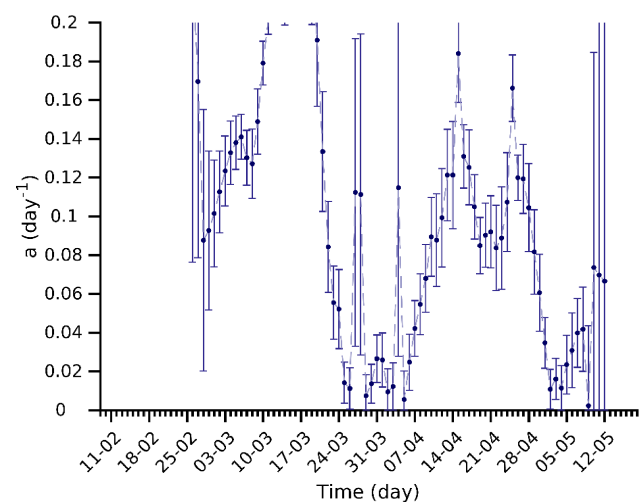
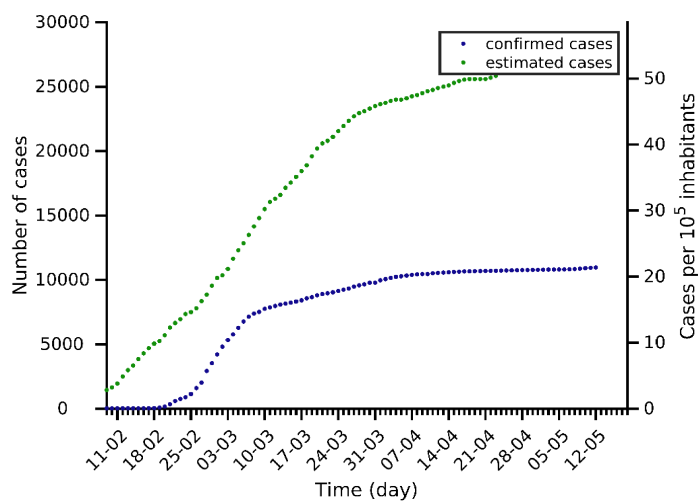
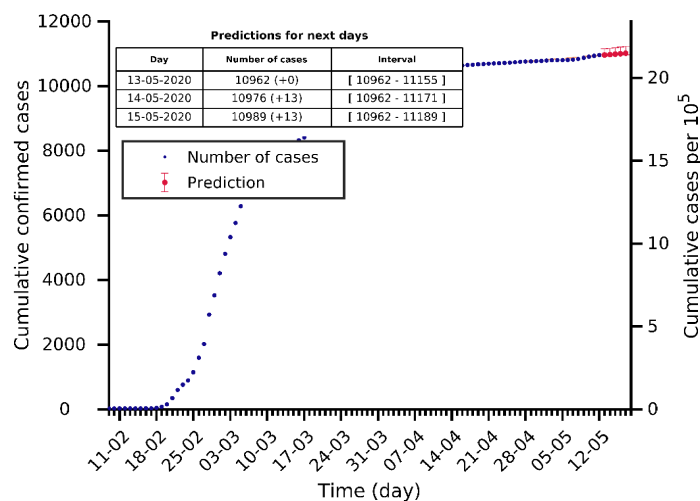
South Africa 12-05-2020. Population: 59.3M. Current cumulated incidence: 19/10⁵



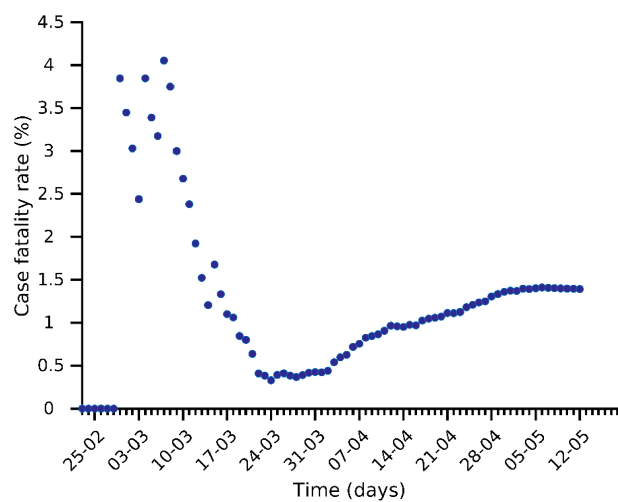
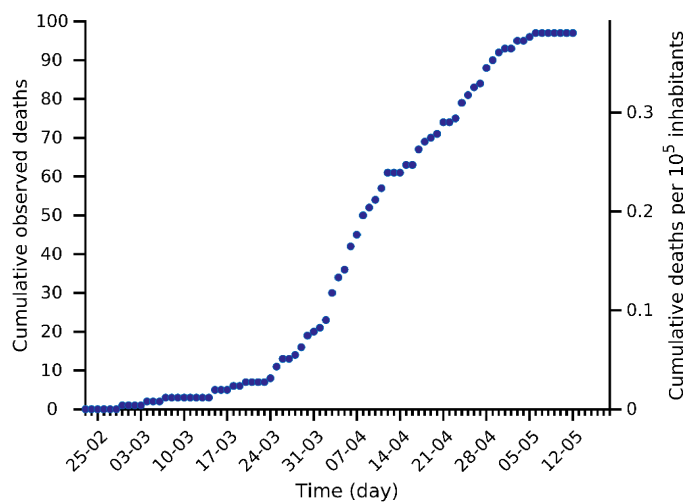
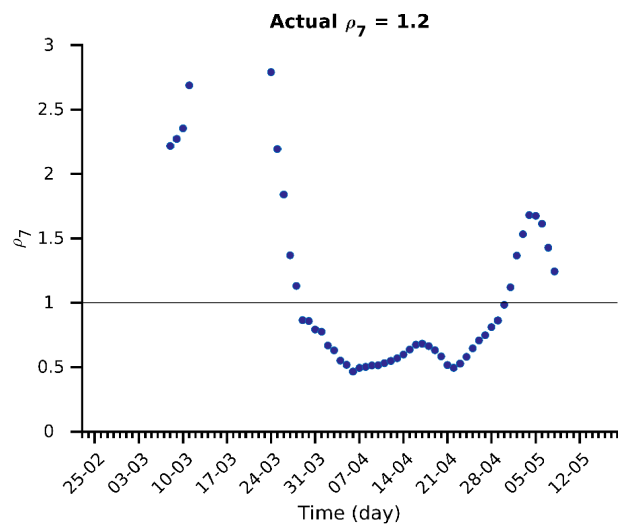
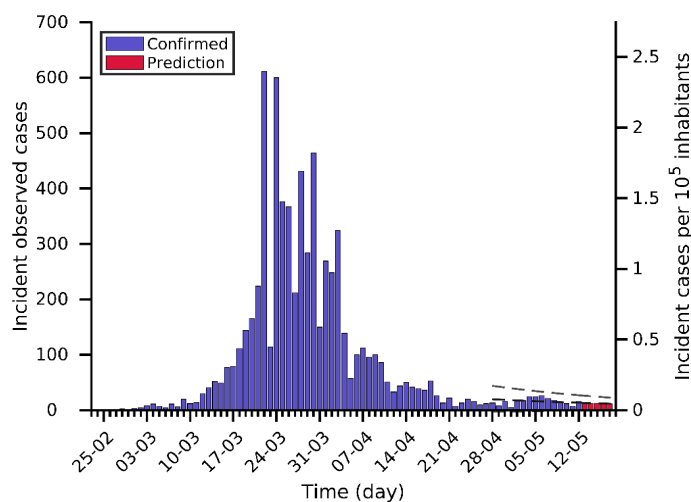
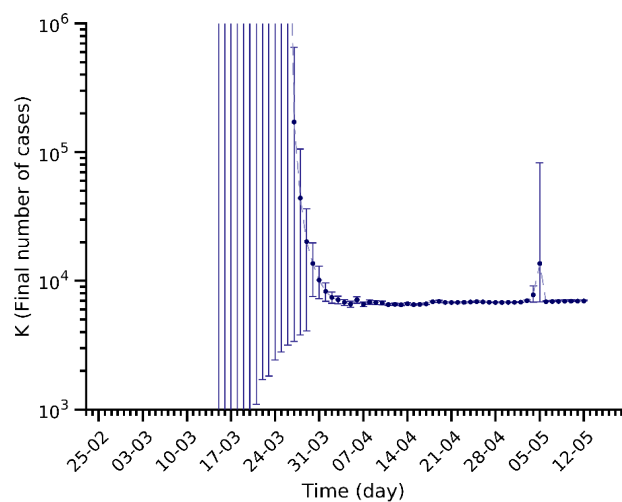
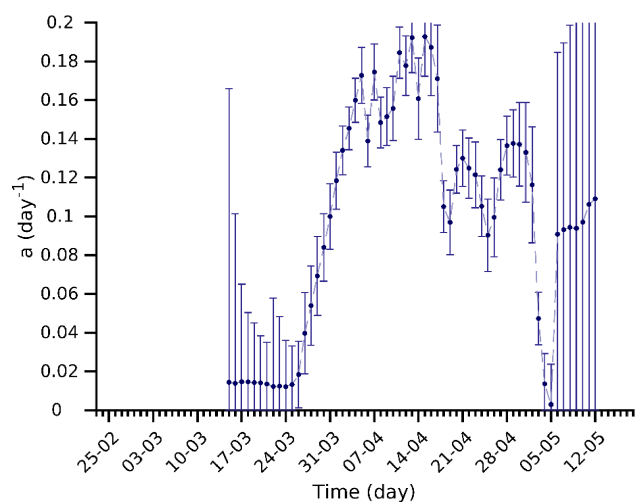
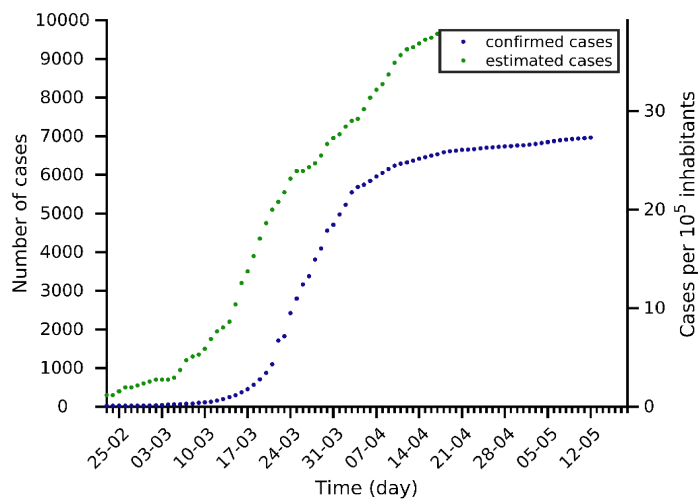
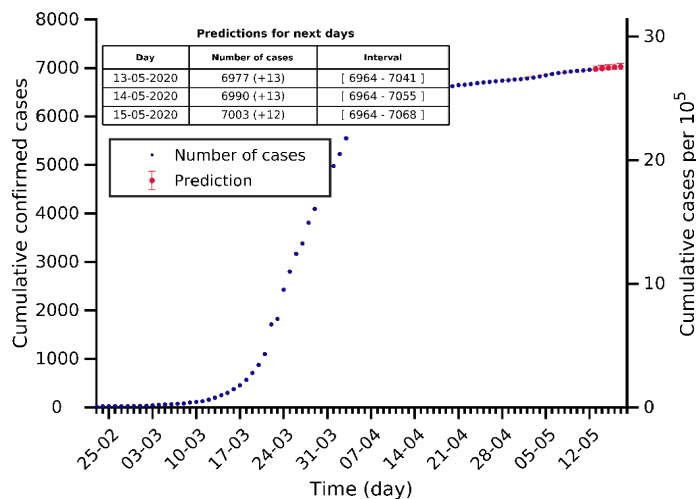
Philippines 12-05-2020. Population: 109.6M. Current cumulated incidence: 10/10⁵



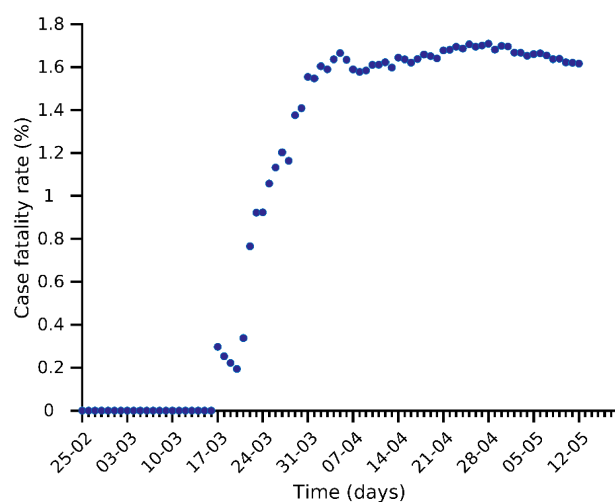
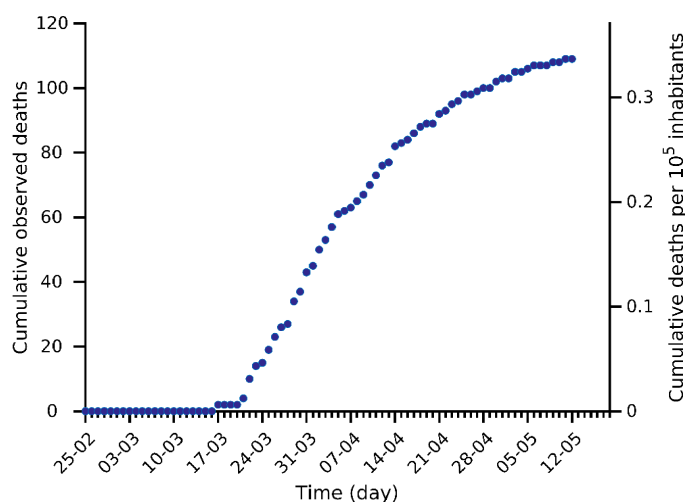
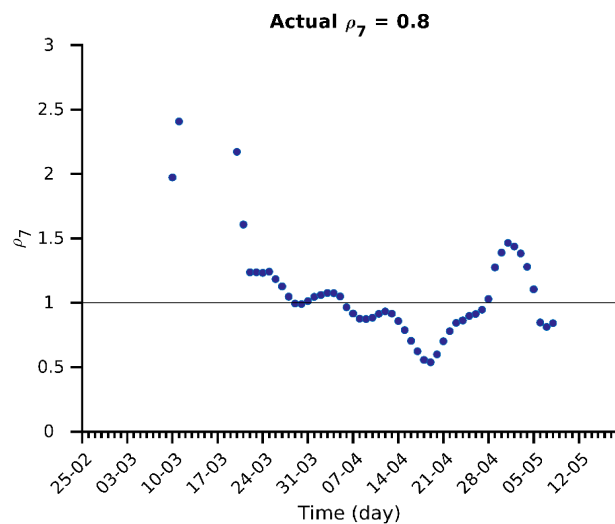
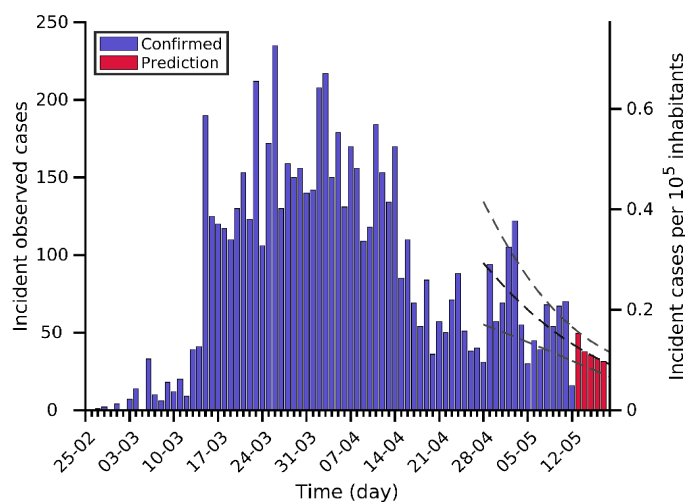
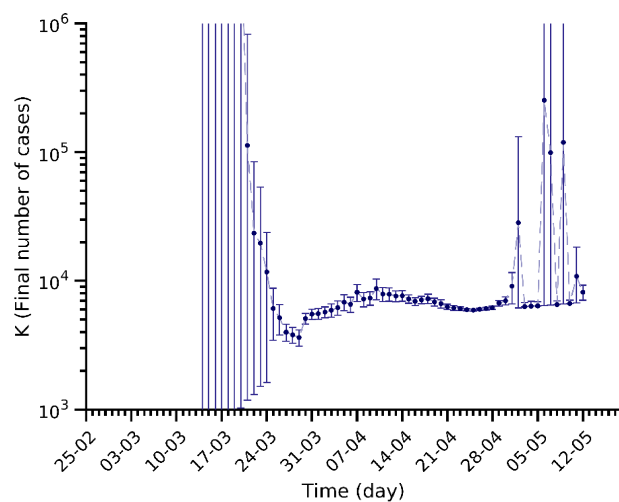
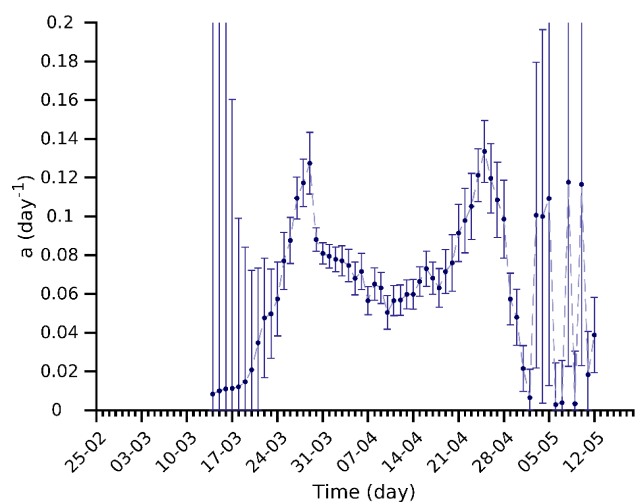
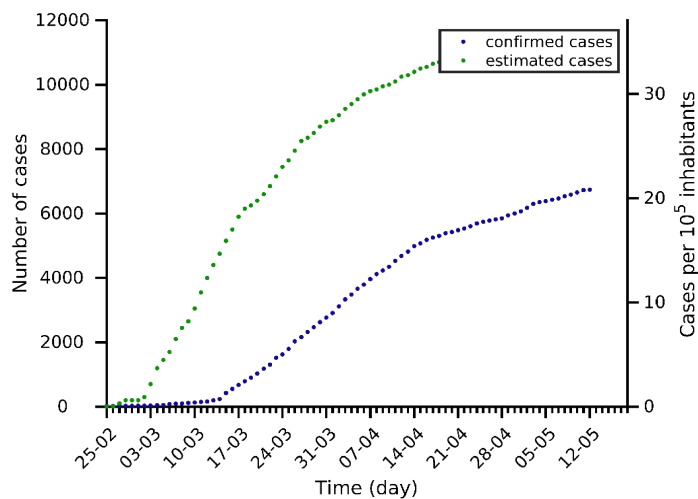
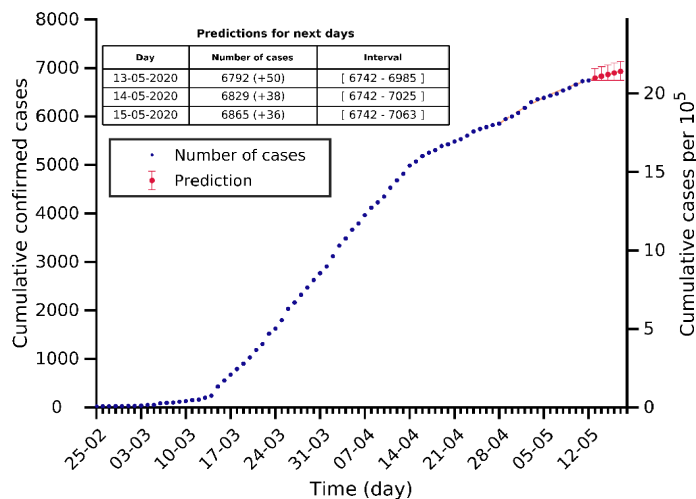
South Korea 12-05-2020. Population: 51.3M. Current cumulated incidence: 21/10⁵



Australia 12-05-2020. Population: 25.5M. Current cumulated incidence: 27/10⁵



Malaysia 12-05-2020. Population: 32.4M. Current cumulated incidence: 21/10⁵

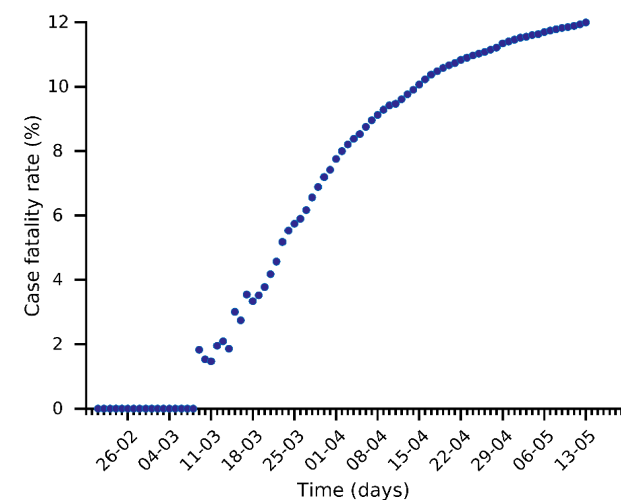
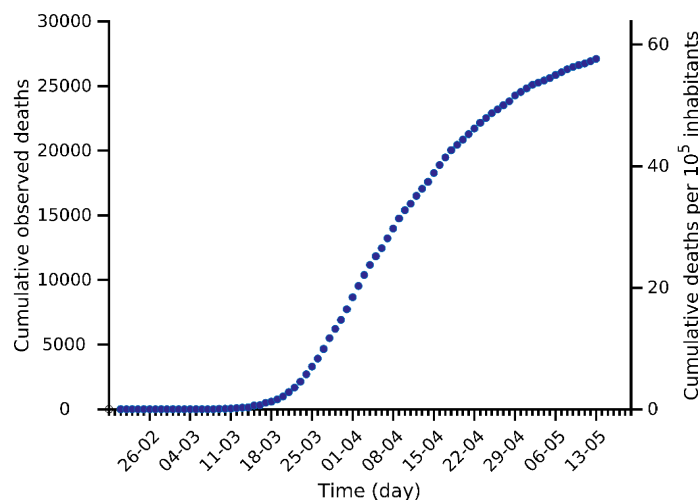
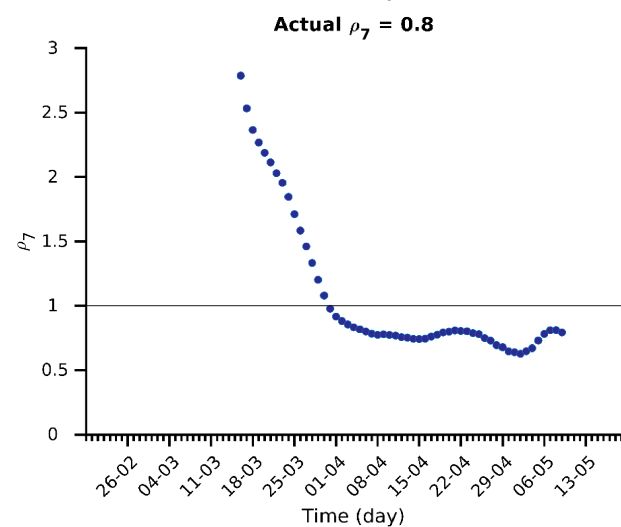
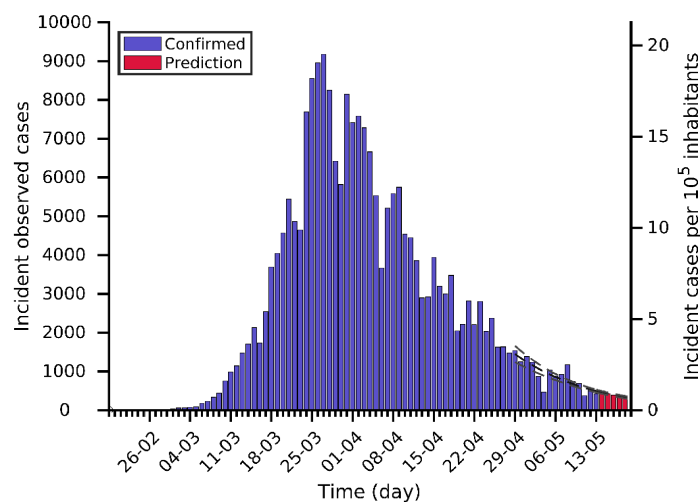
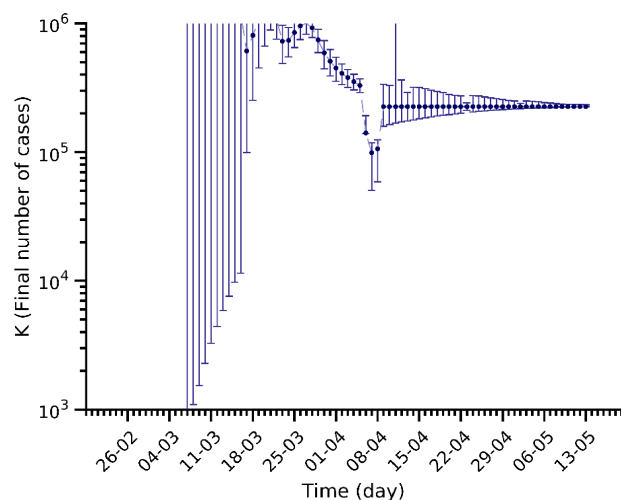
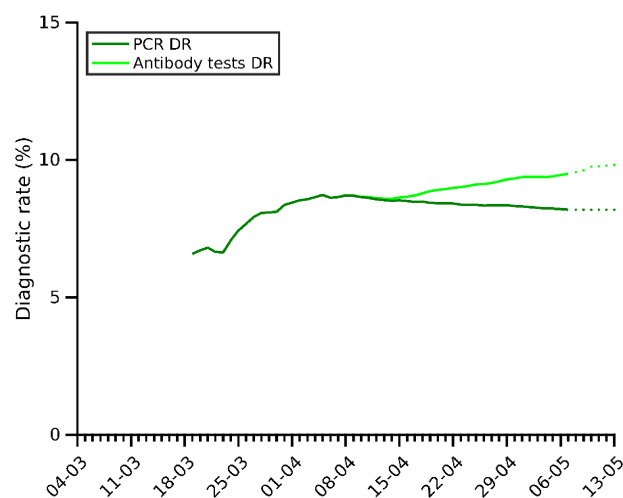
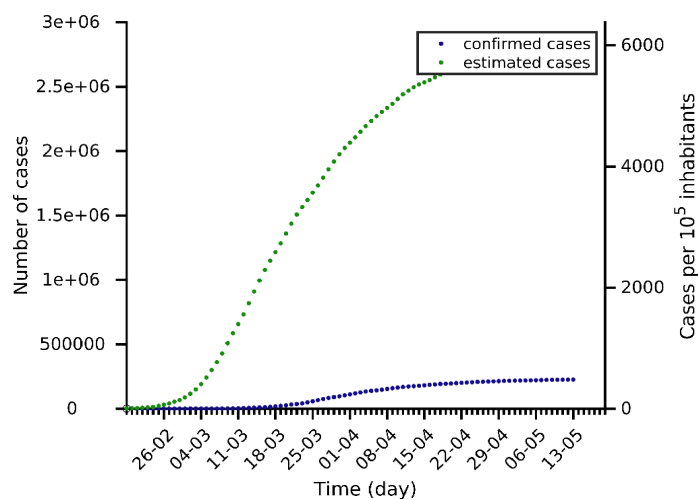
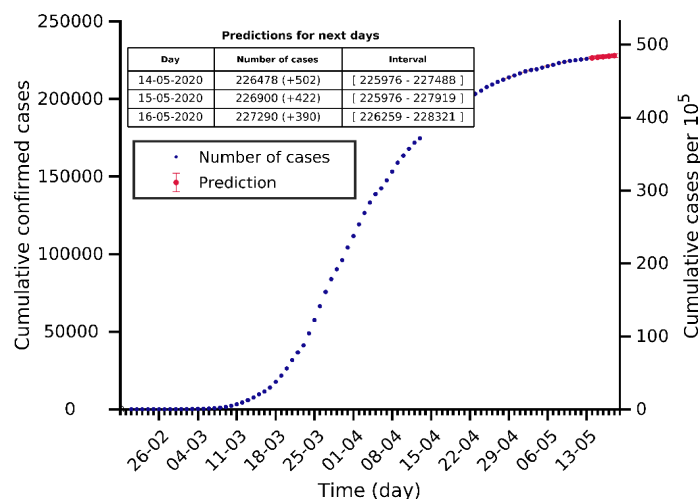


(3) Analysis and prediction of COVID-19 for Spain and its autonomous communities

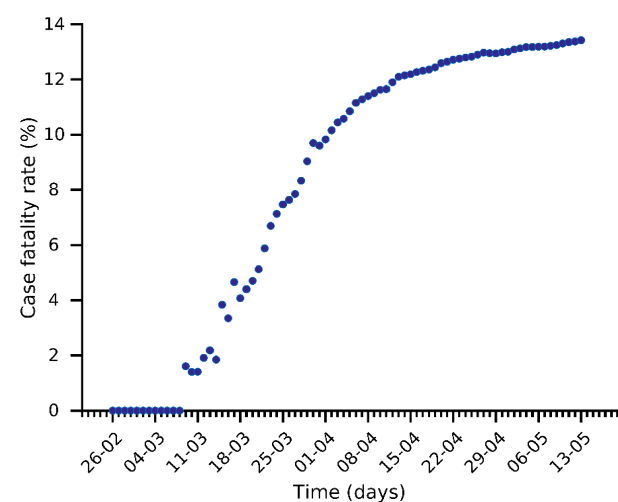
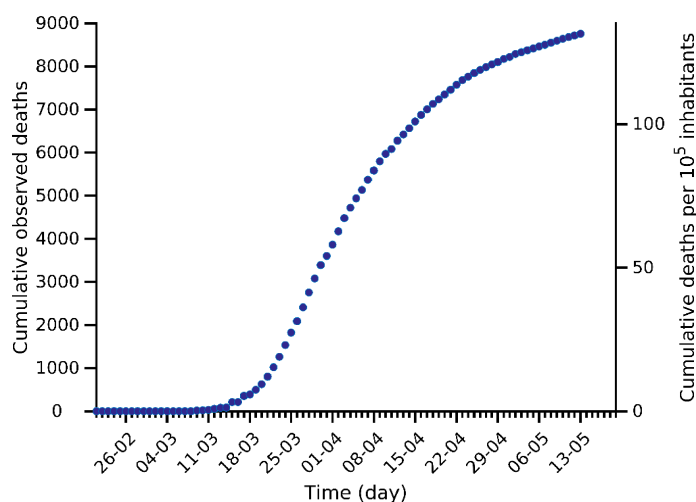
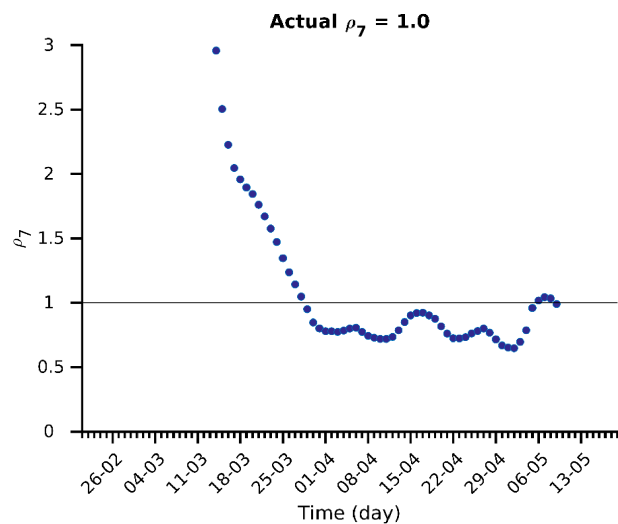
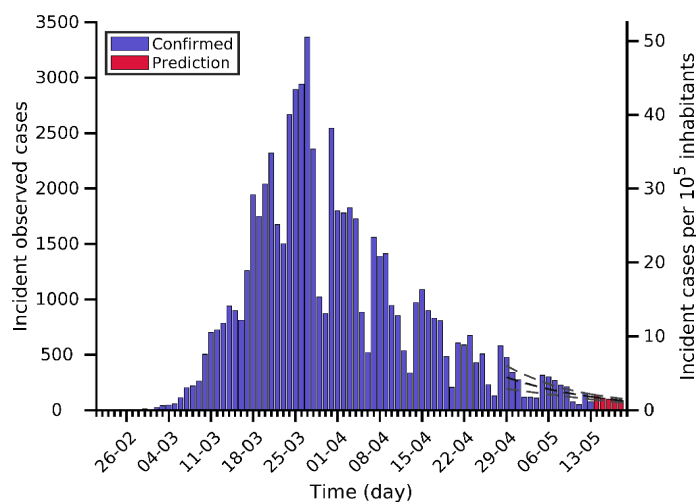
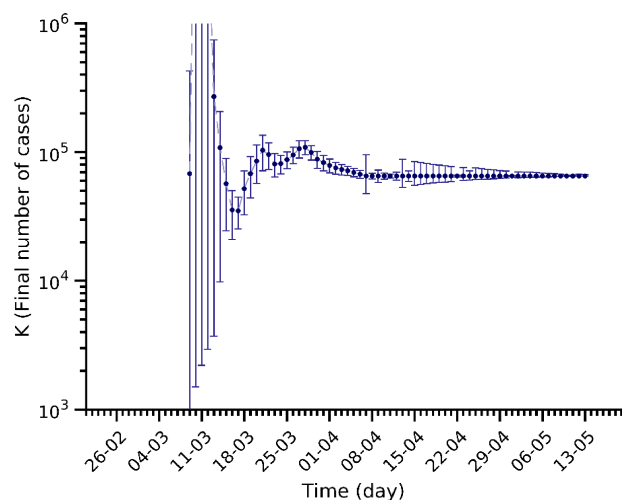
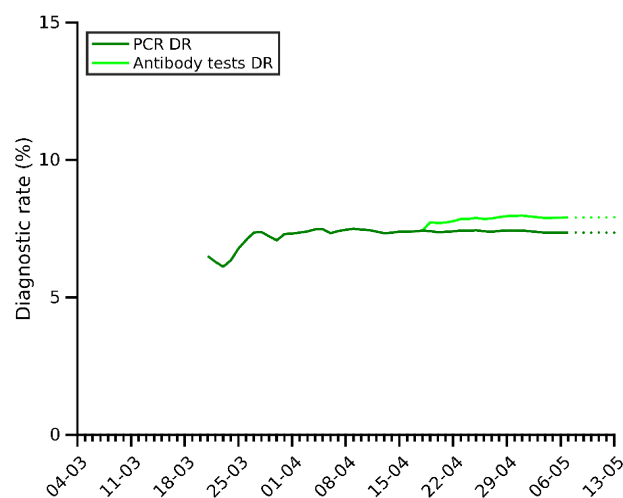
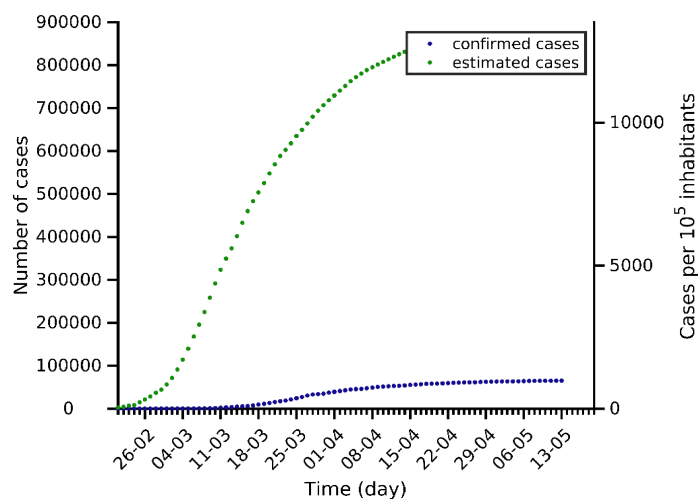
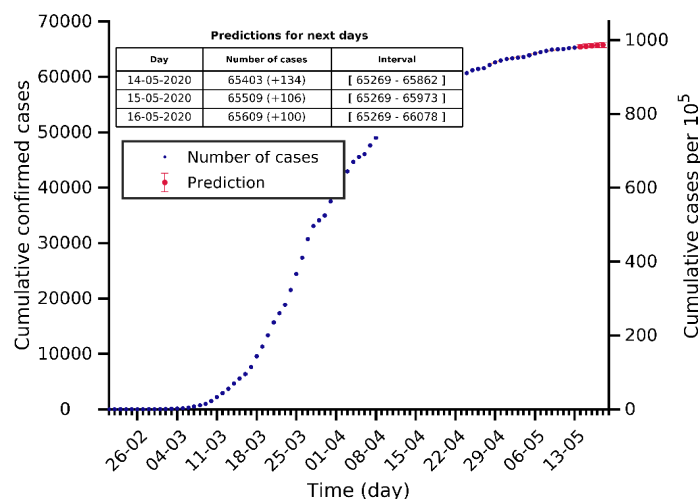
WARNING: Spain is revising Catalan data series. Data used for this part of the report are provisional (2,715 new cases that are pending to be assigned to correct date have been temporary removed)

Data obtained from <https://github.com/datadista/datasets/tree/master/COVID%2019> and <https://covid19.isciii.es/>

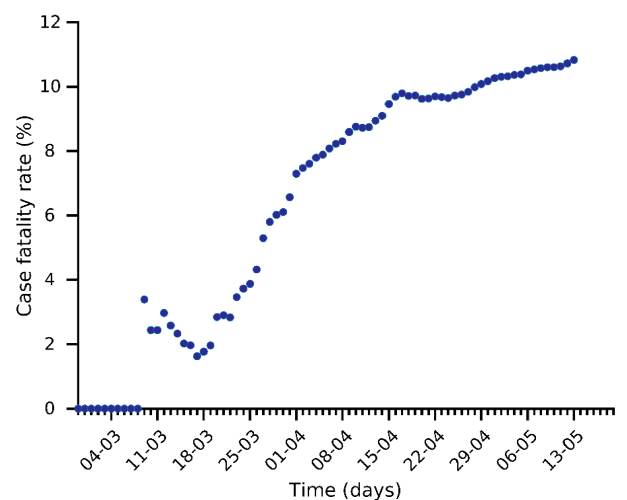
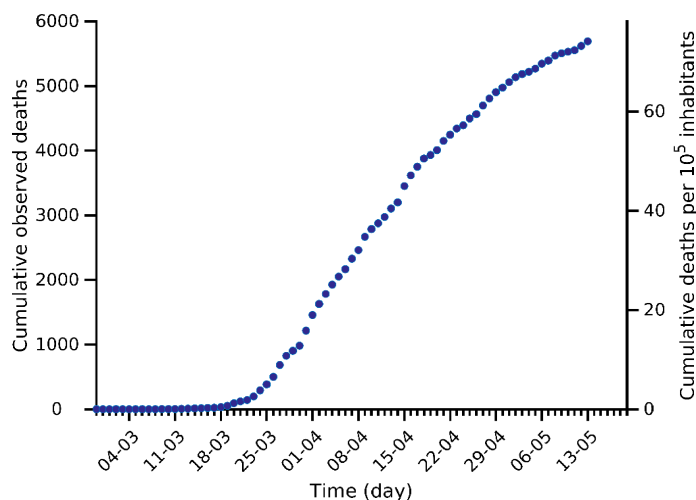
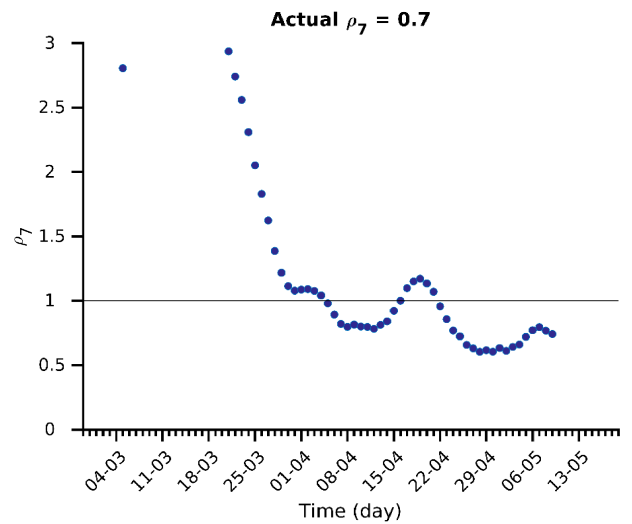
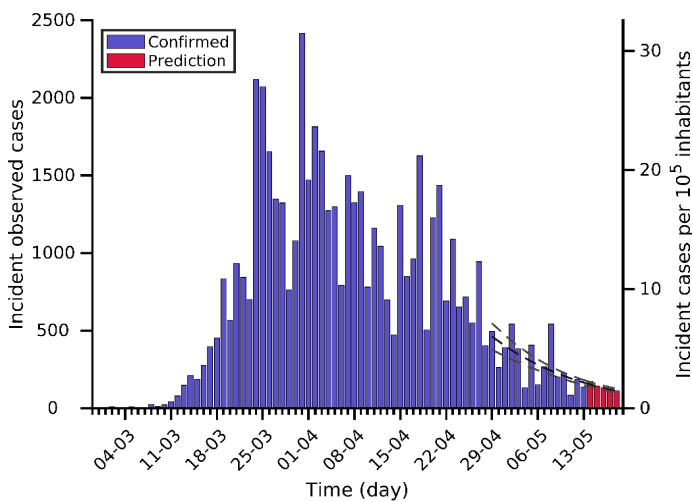
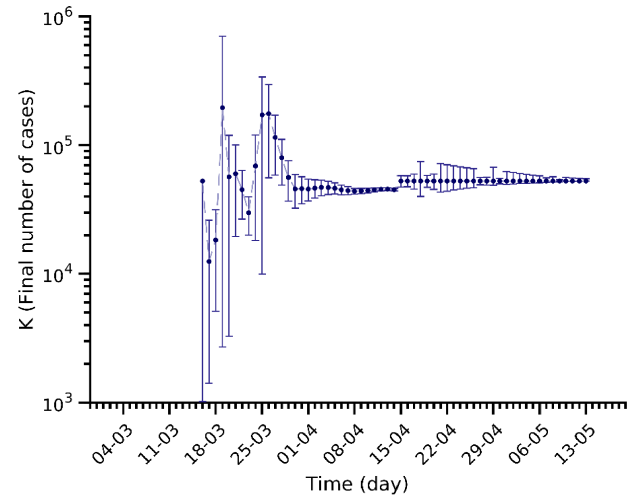
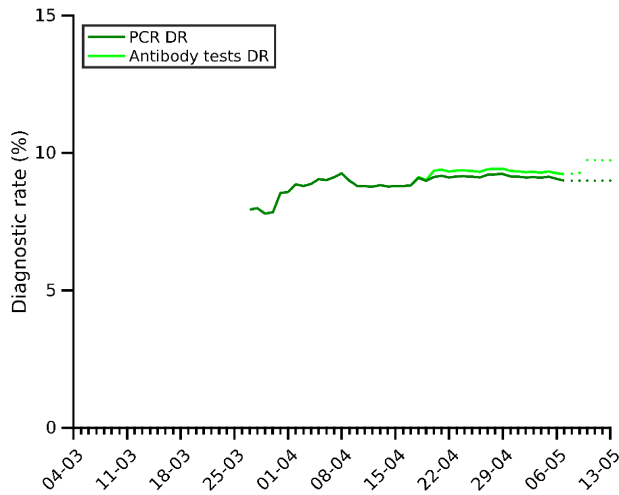
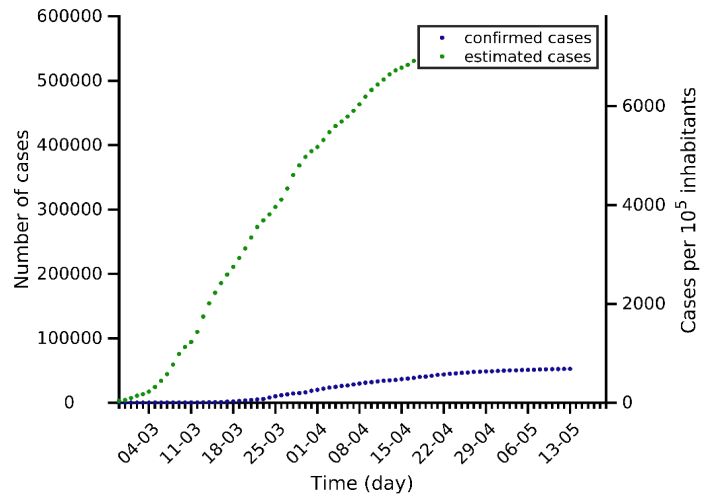
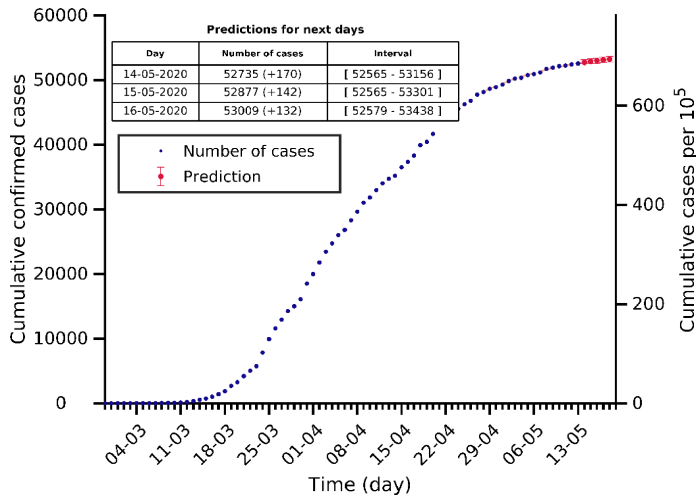
Spain 13-05-2020. Population: 47.0M. Current cumulated incidence: 481/10⁵



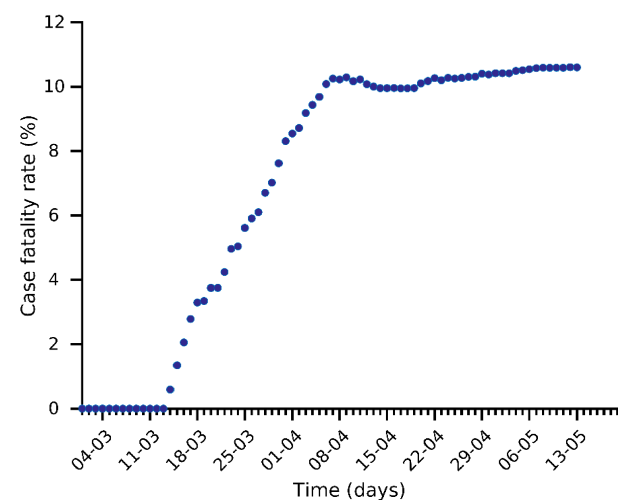
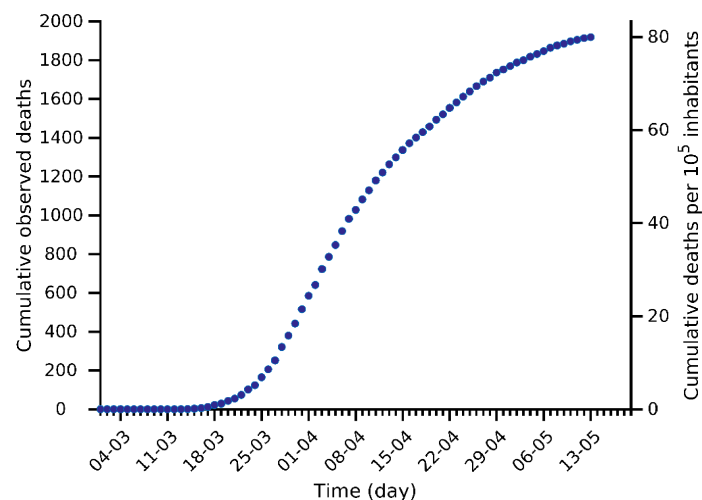
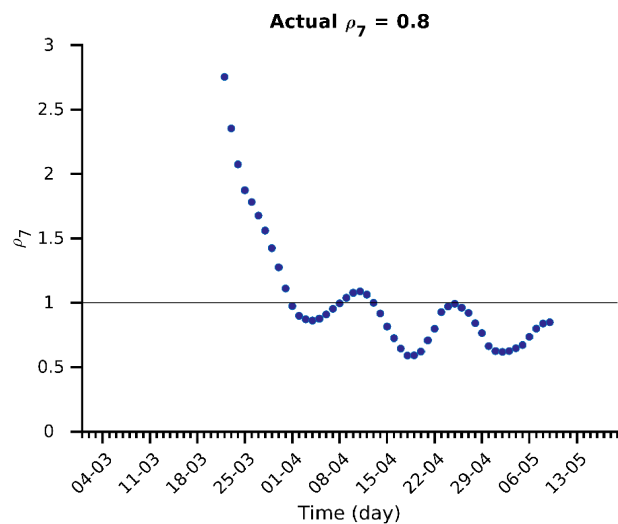
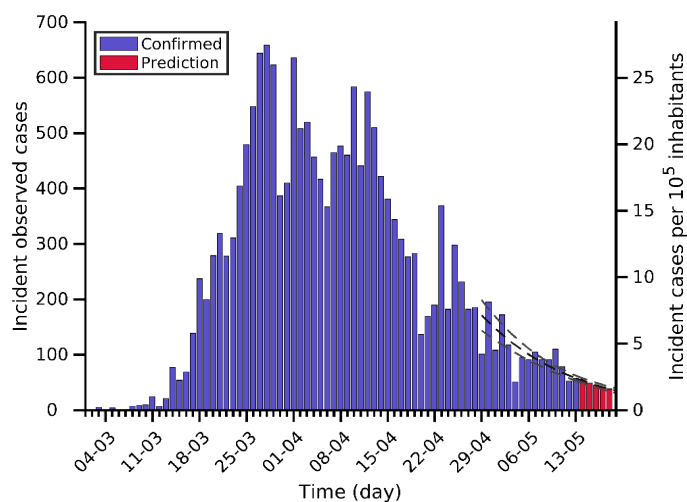
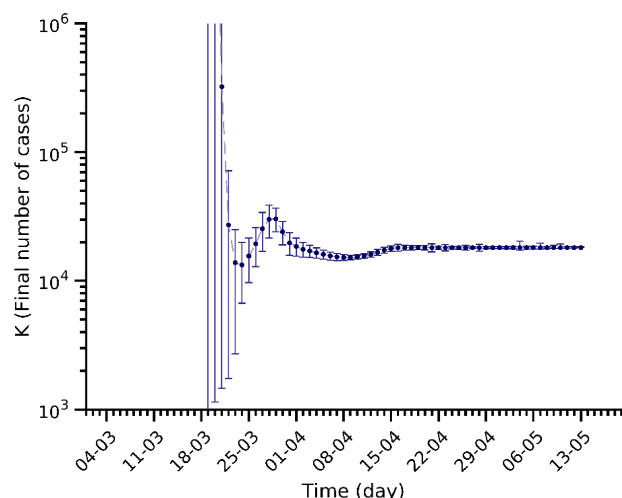
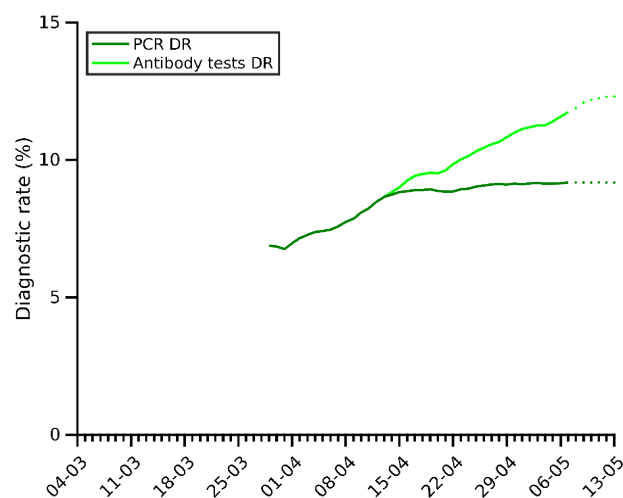
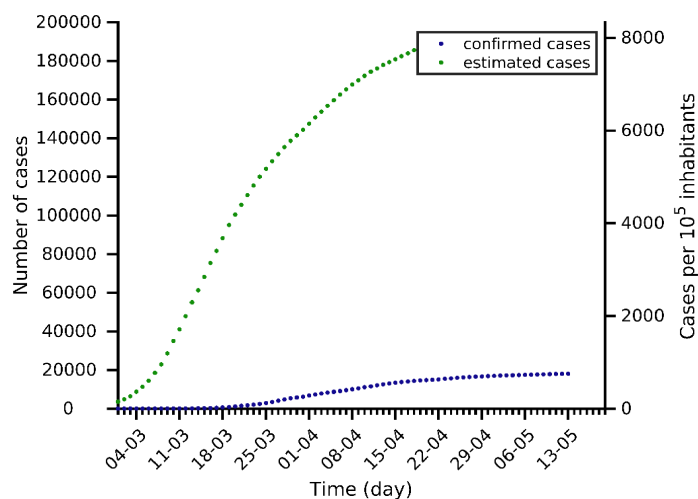
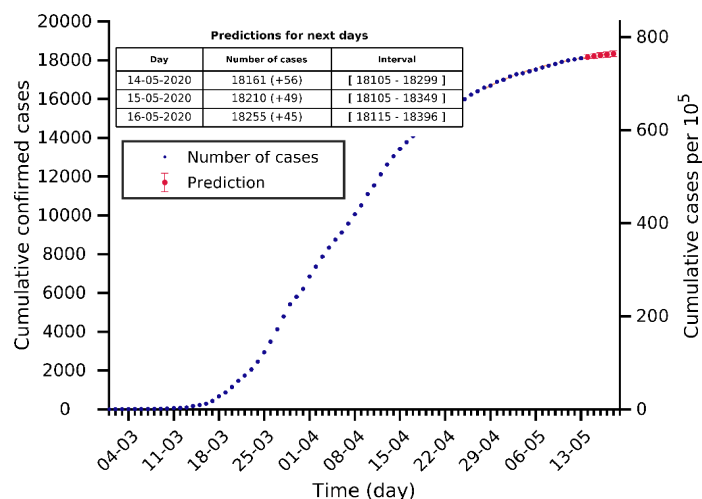
Madrid 13-05-2020. Population: 6.7M. Current cumulated incidence: 980/10⁵



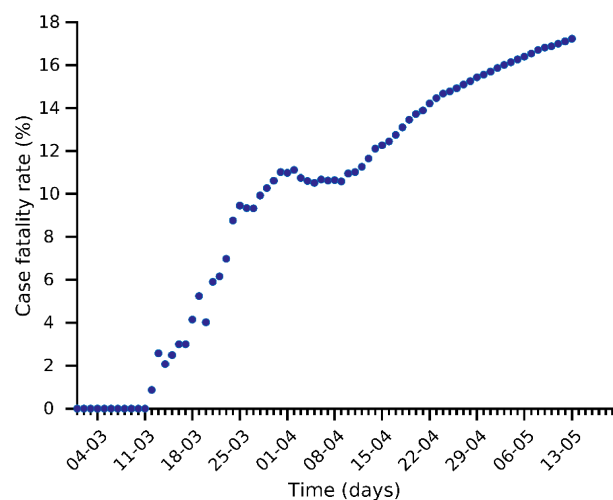
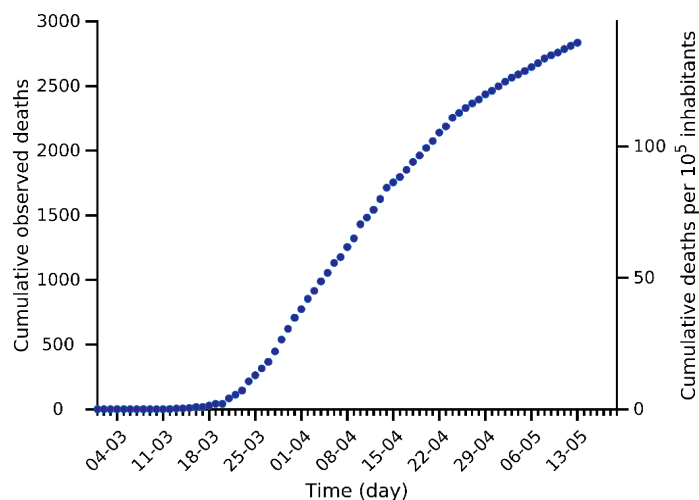
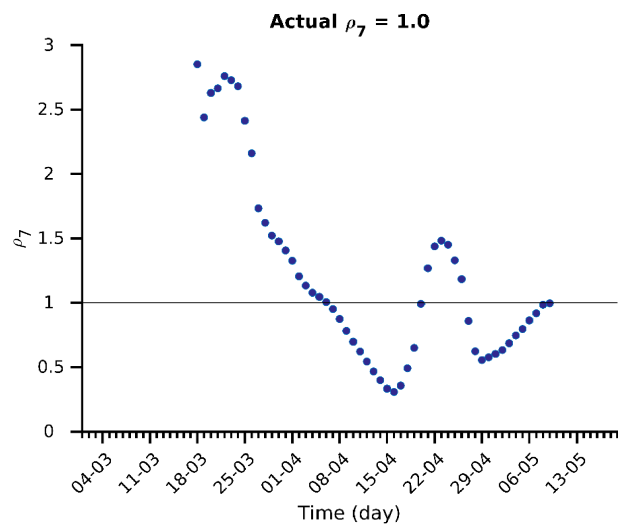
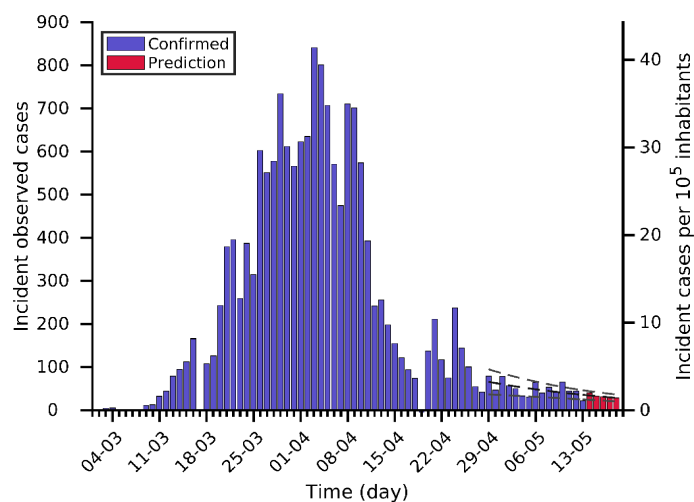
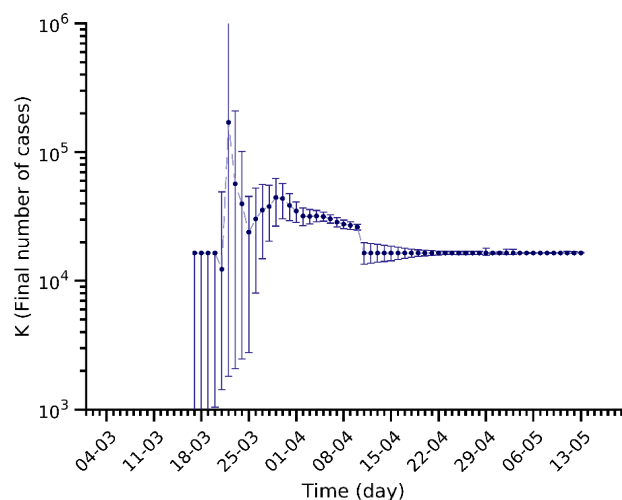
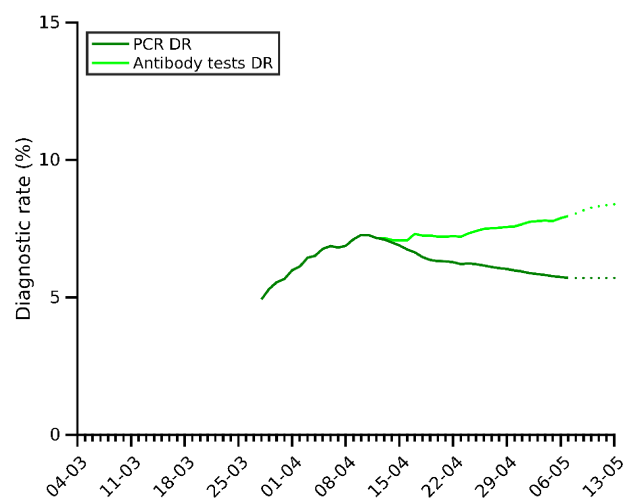
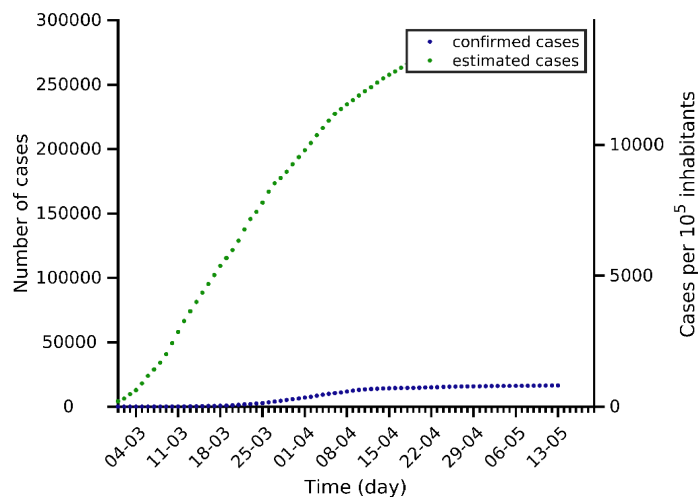
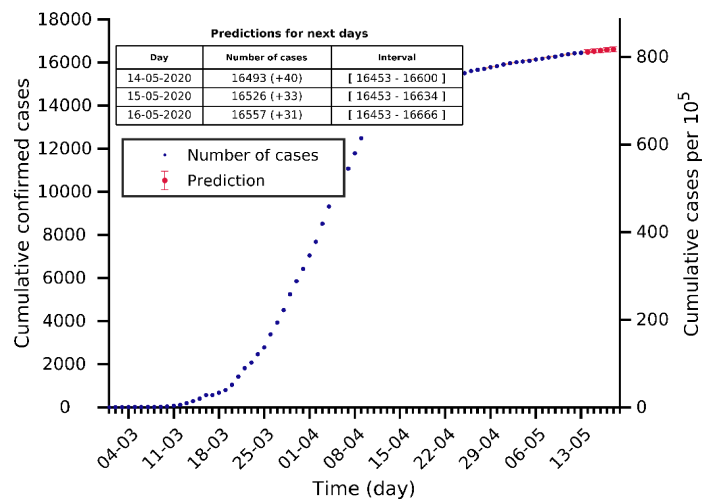
Catalunya 13-05-2020. Population: 7.7M. Current cumulated incidence: 685/10⁵



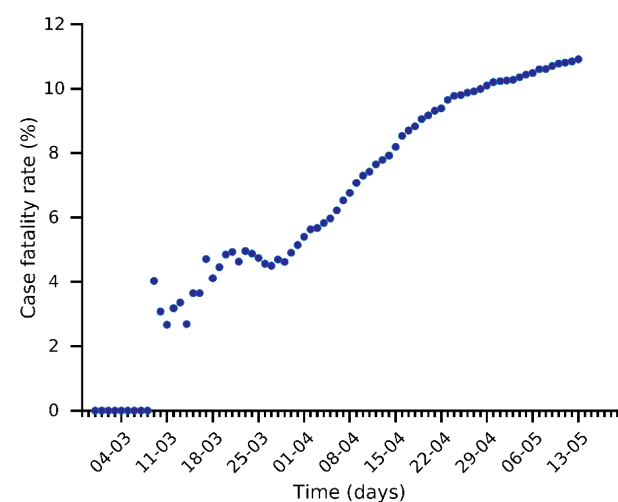
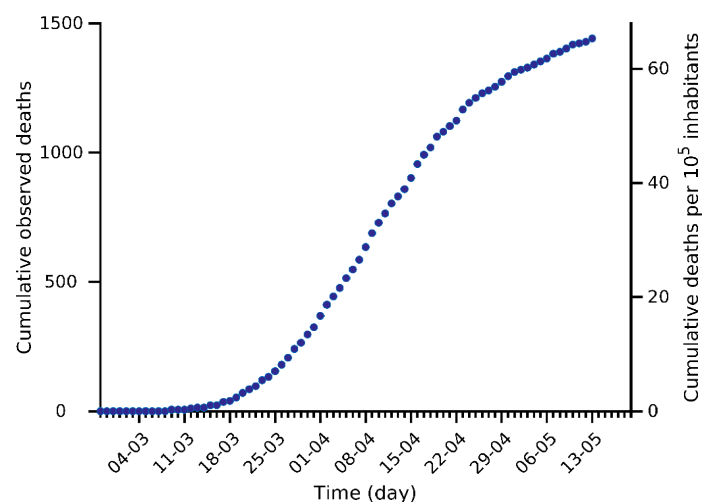
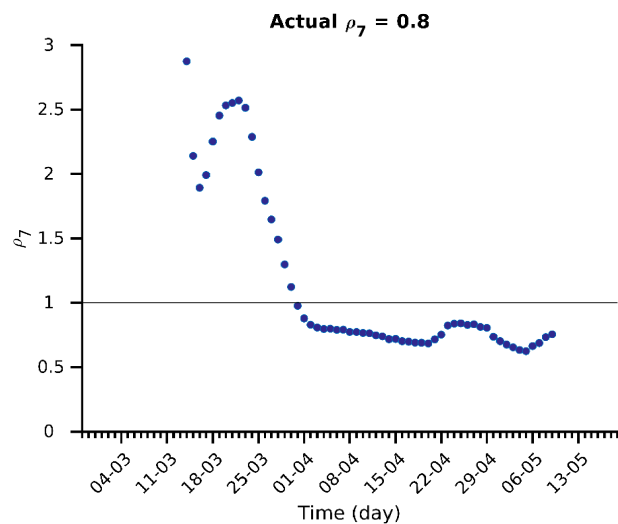
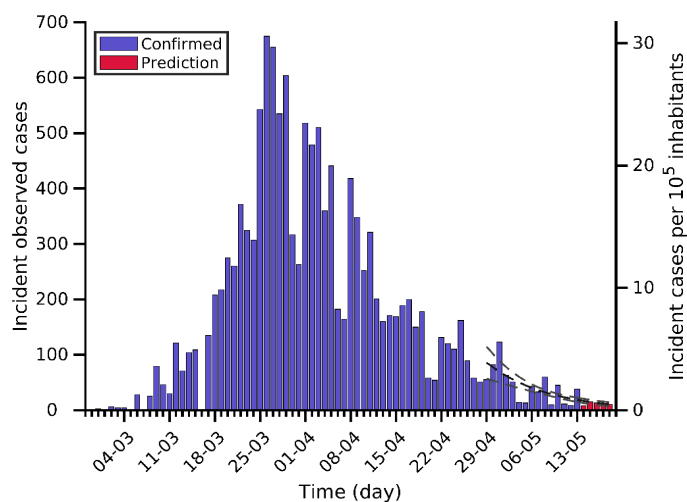
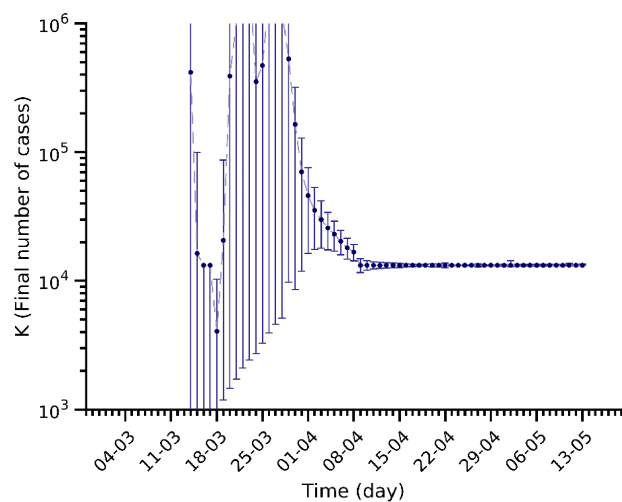
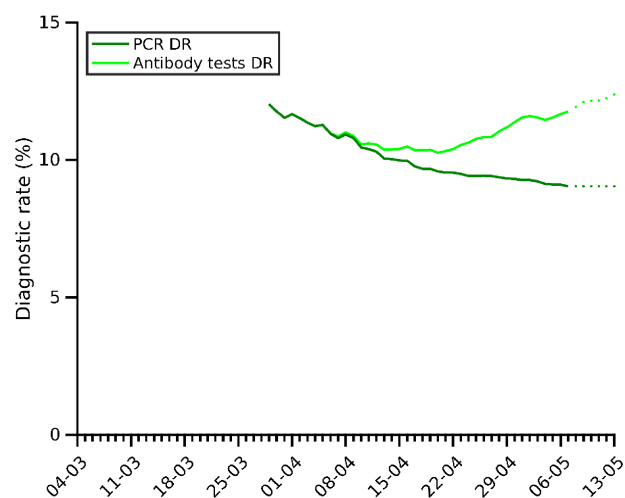
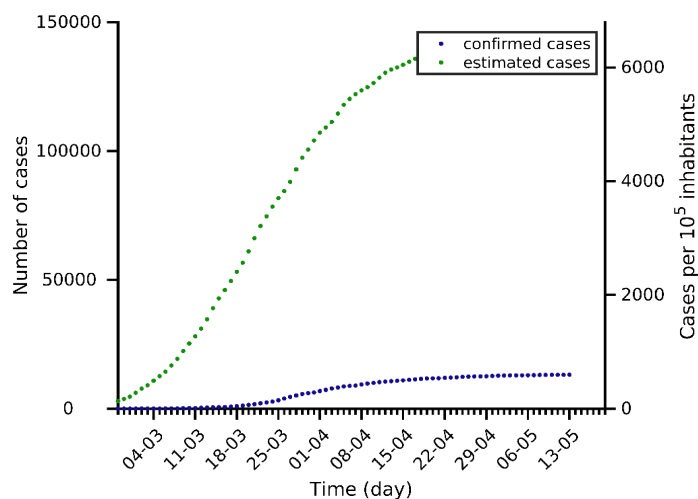
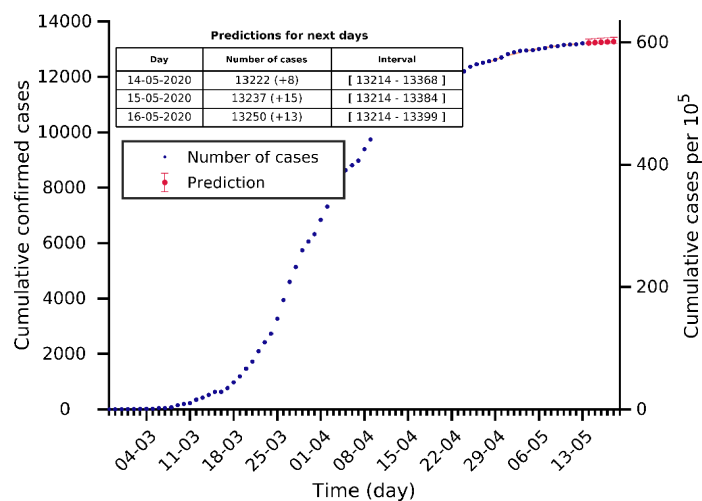
Castilla Leon 13-05-2020. Population: 2.4M. Current cumulated incidence: 755/10⁵



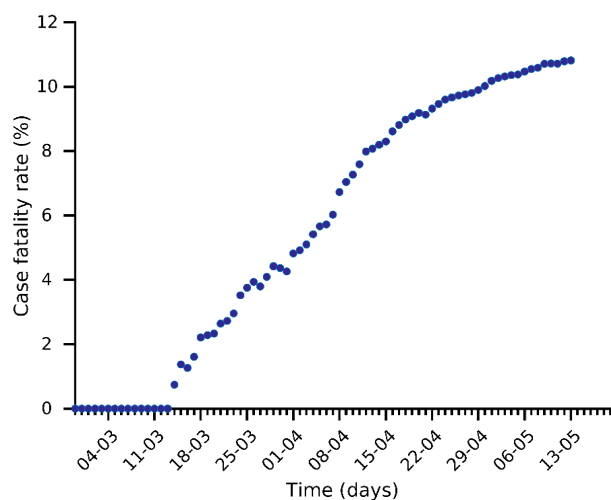
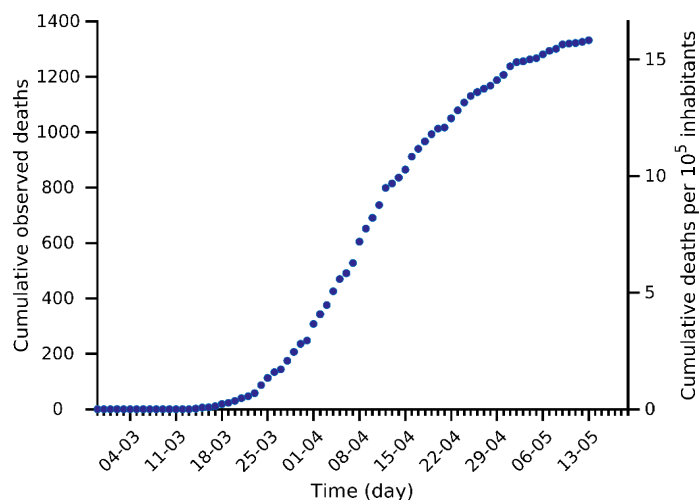
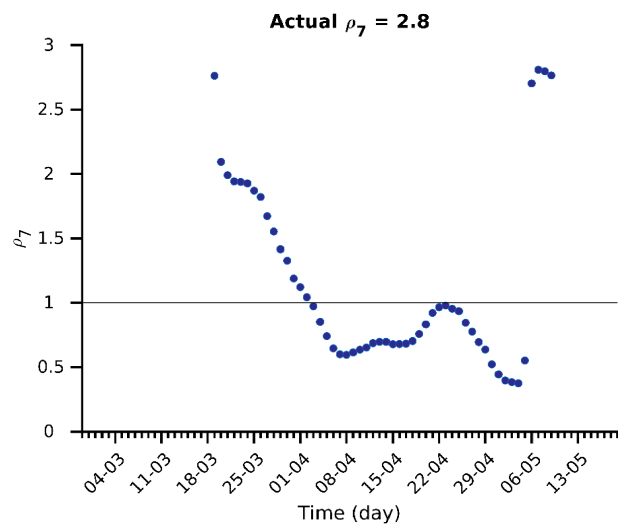
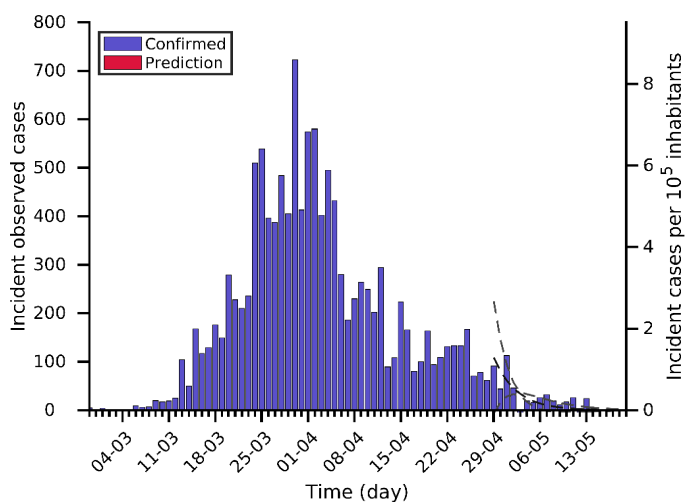
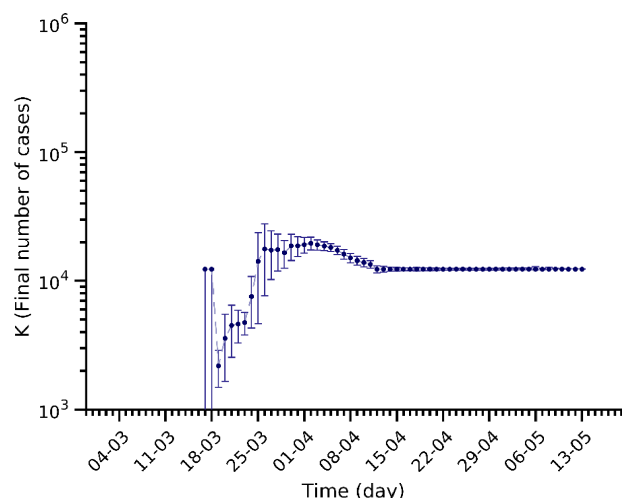
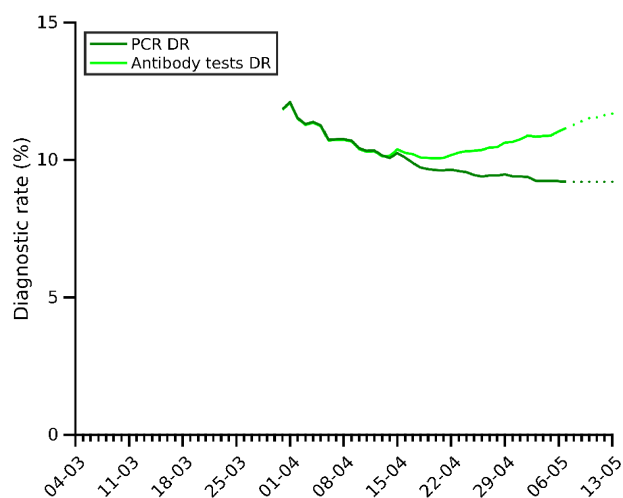
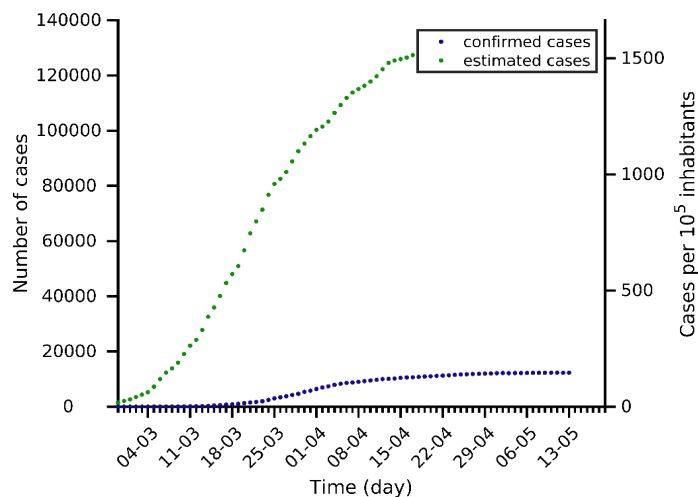
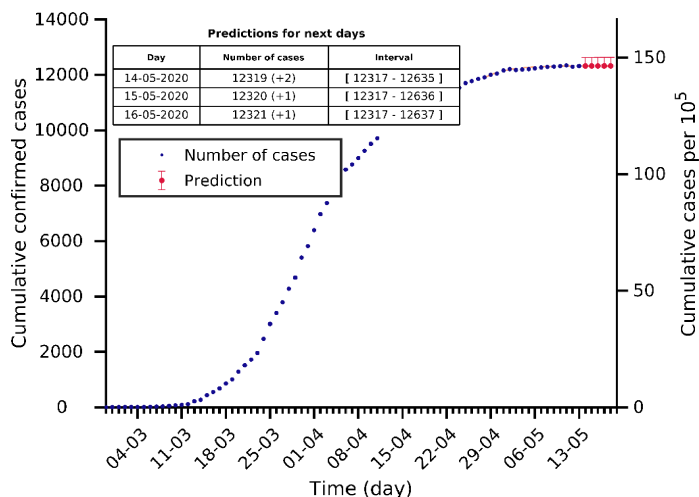
Castilla-La Mancha 13-05-2020. Population: 2.0M. Current cumulated incidence: 80



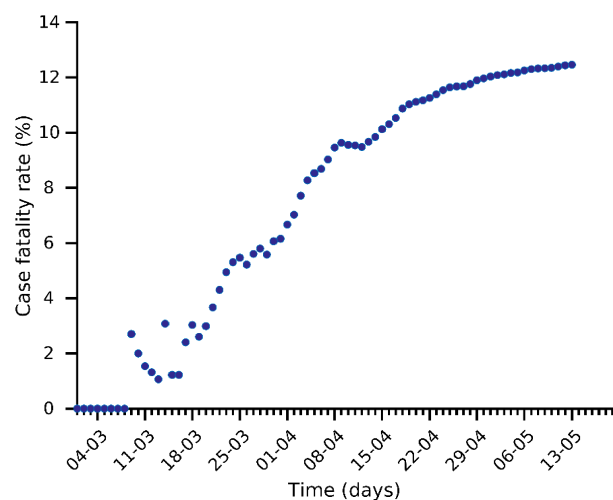
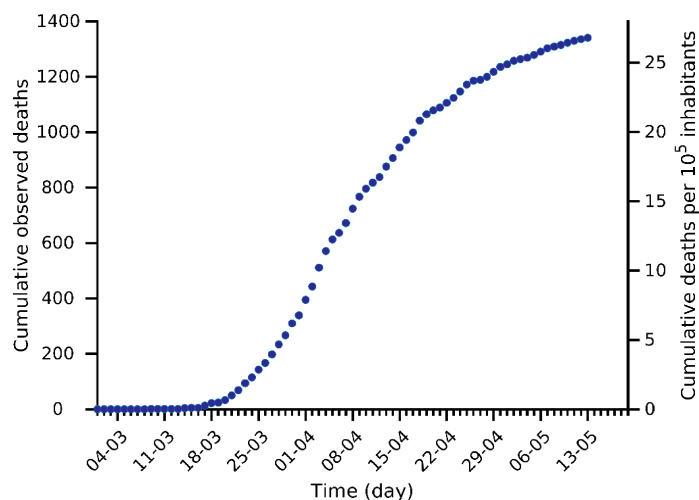
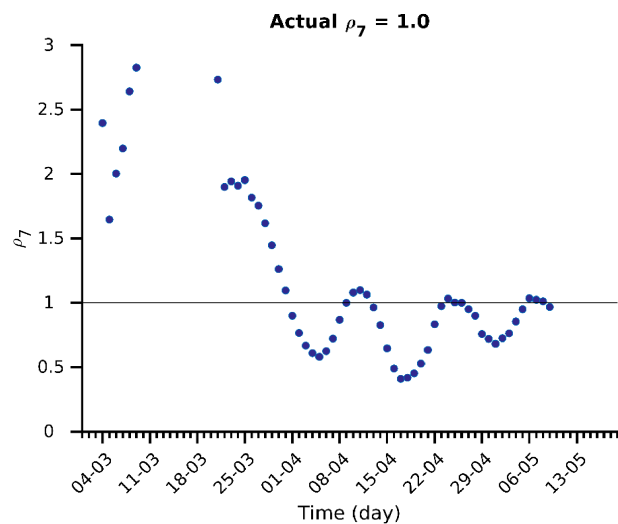
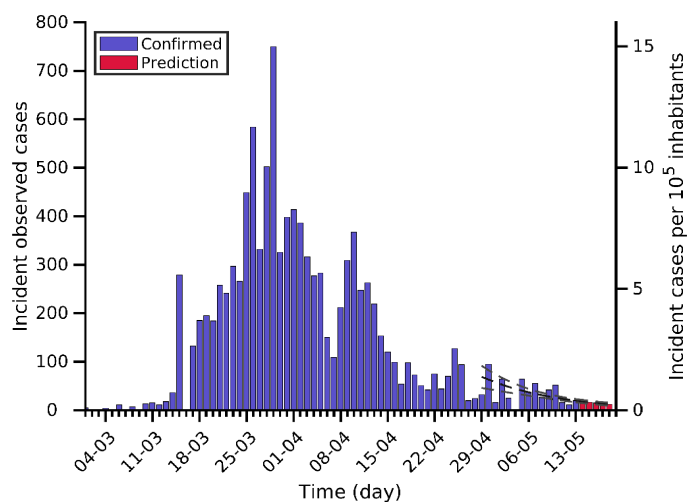
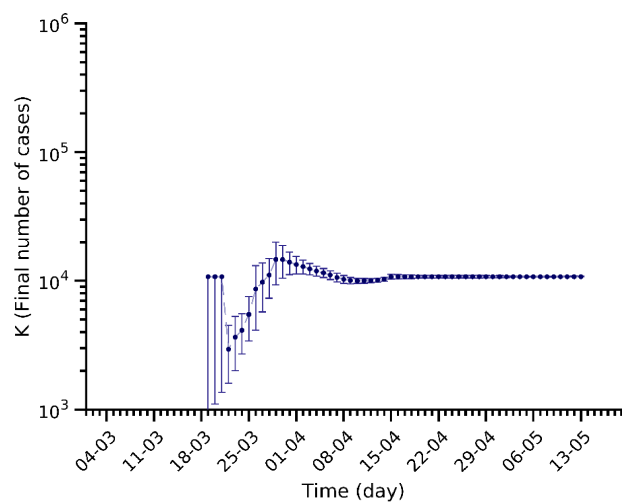
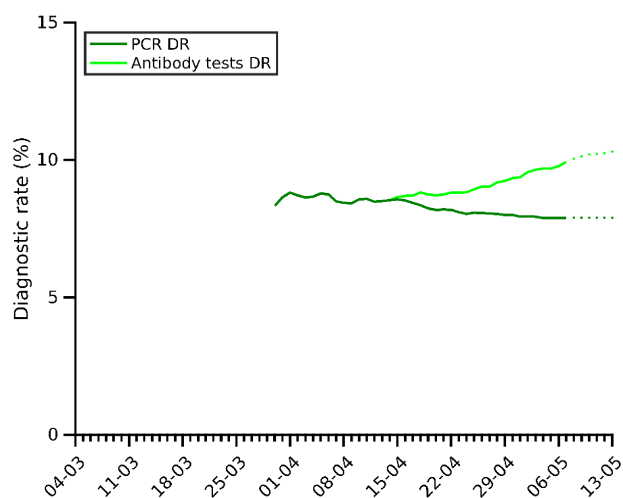
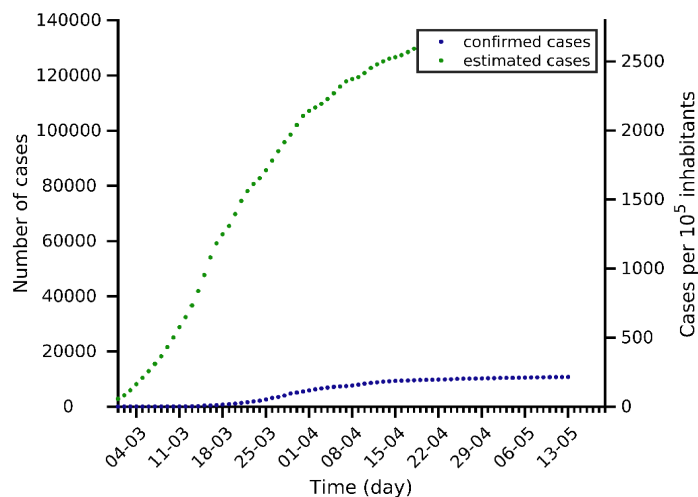
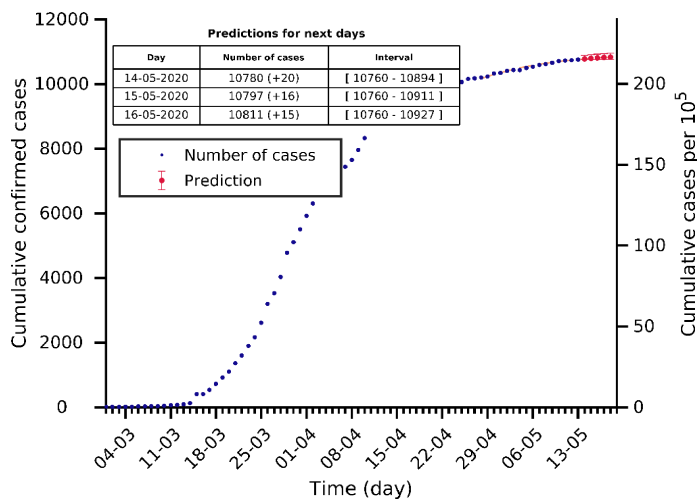
Euskadi 13-05-2020. Population: 2.2M. Current cumulated incidence: 599/10⁵



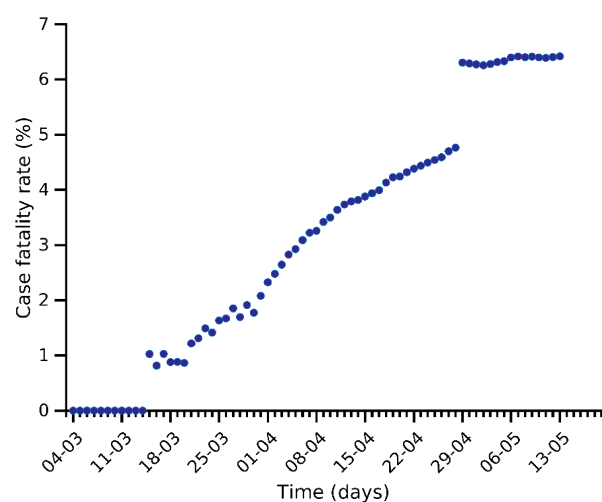
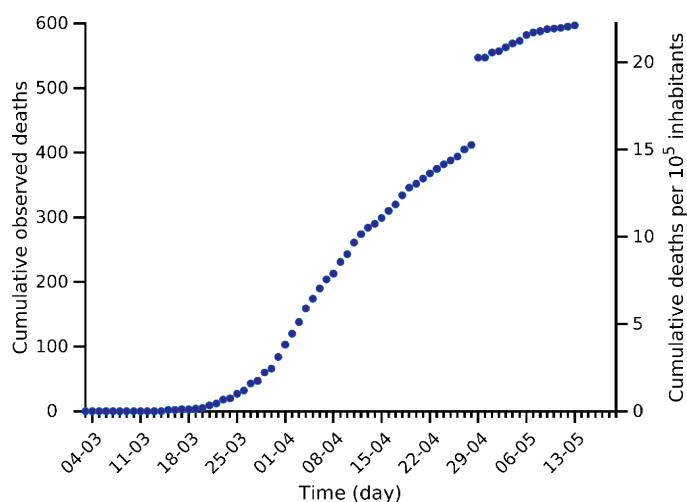
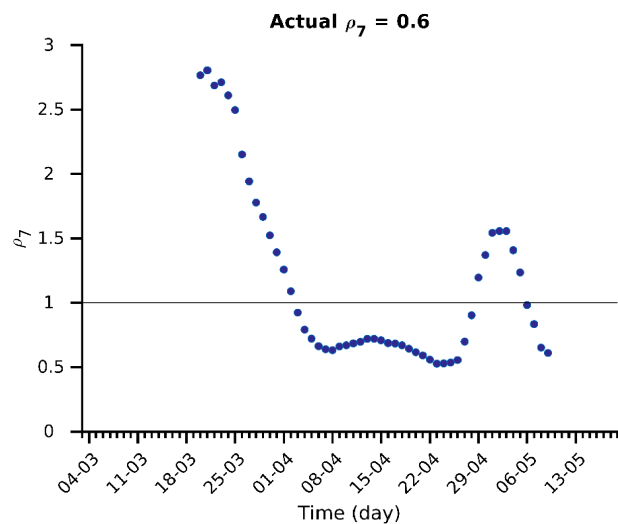
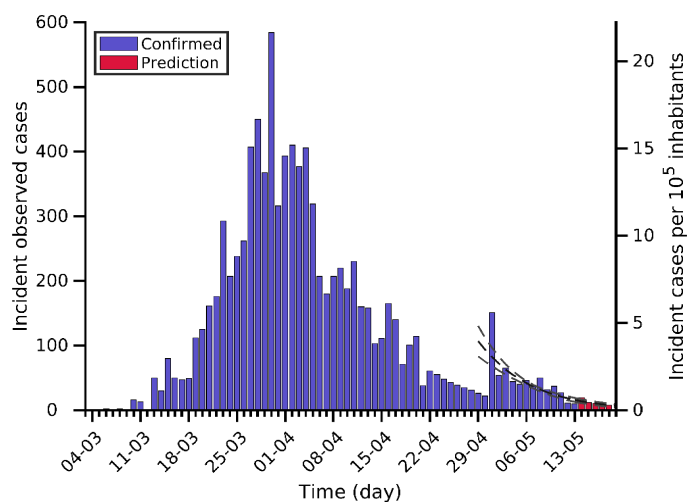
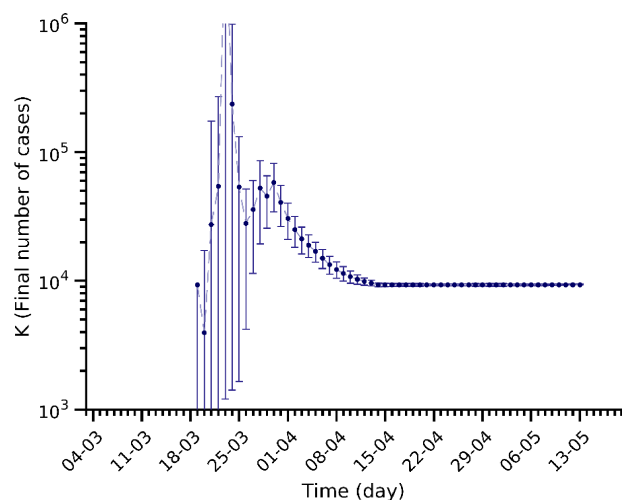
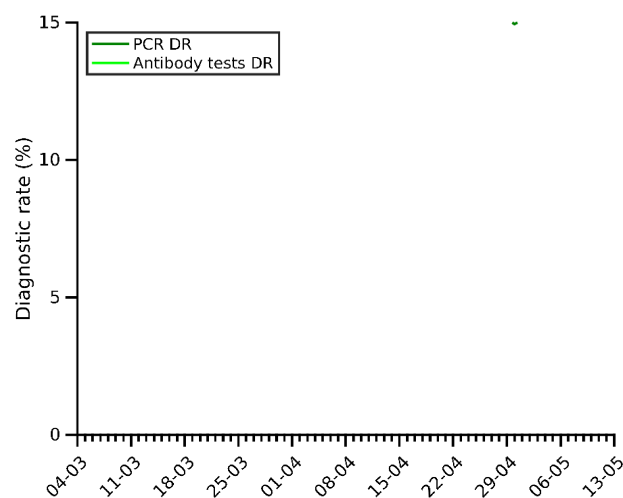
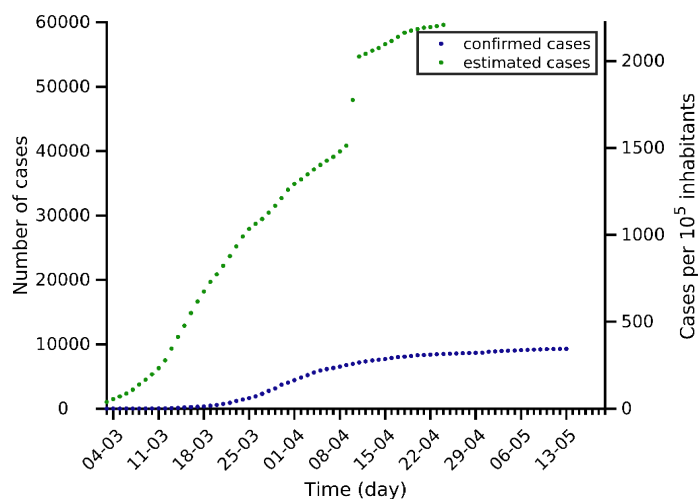
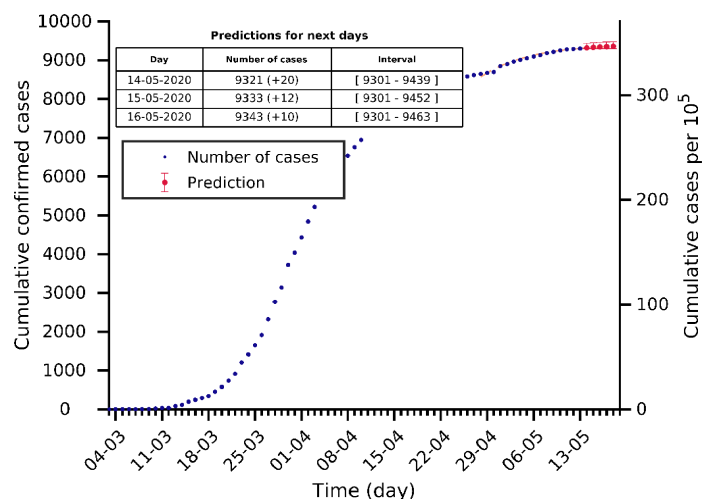
Andalucia 13-05-2020. Population: 8.4M. Current cumulated incidence: 146/10⁵



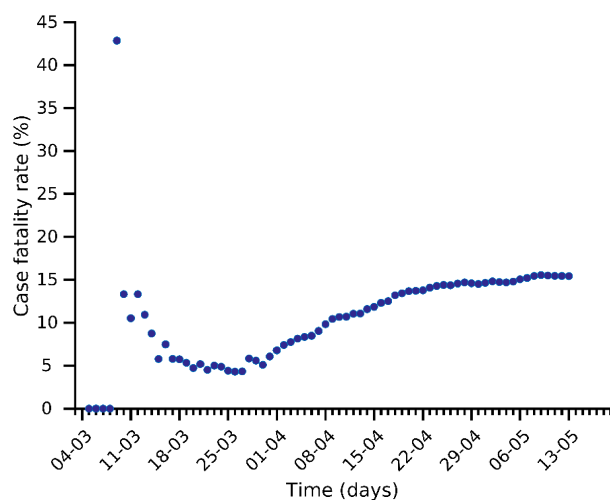
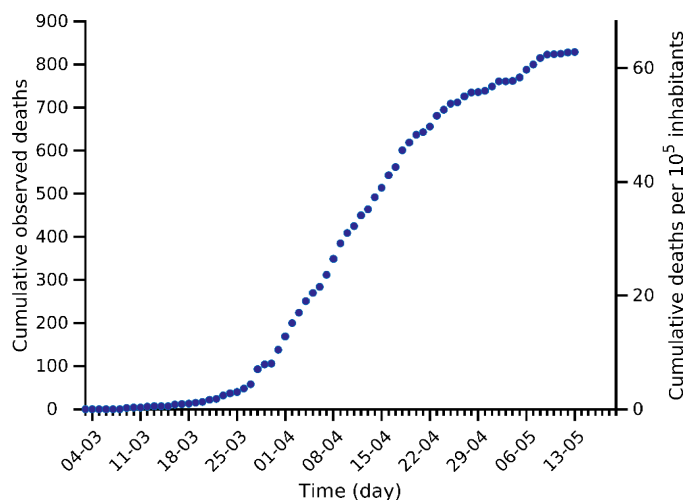
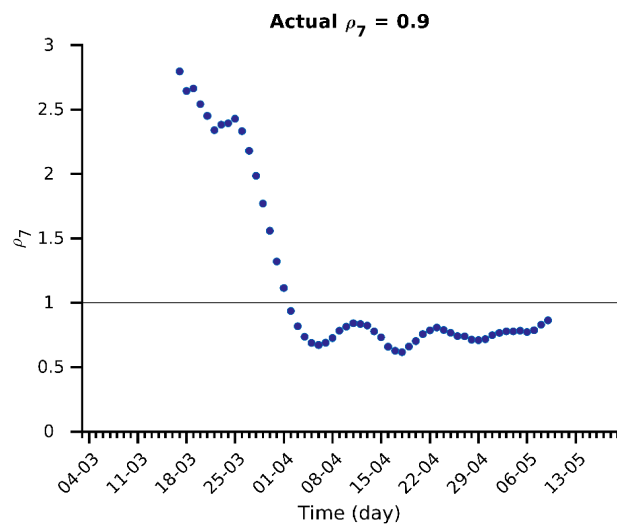
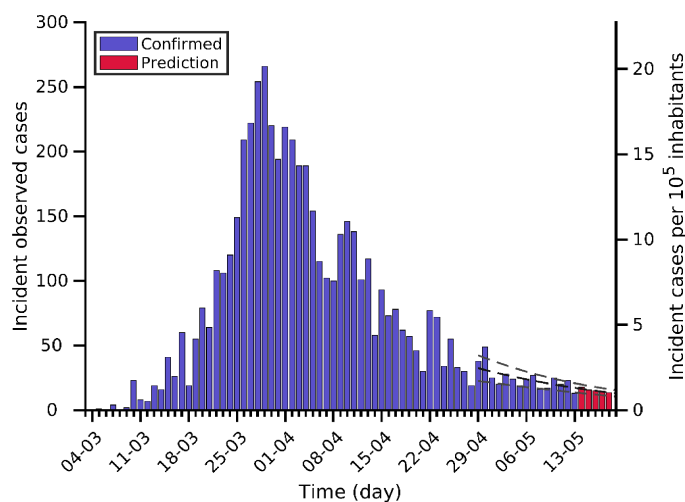
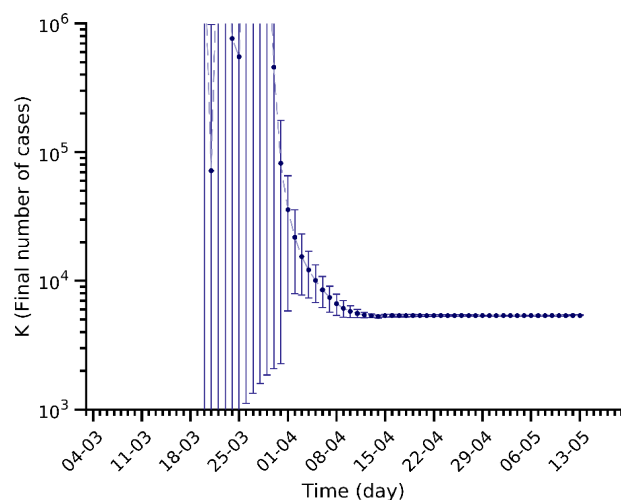
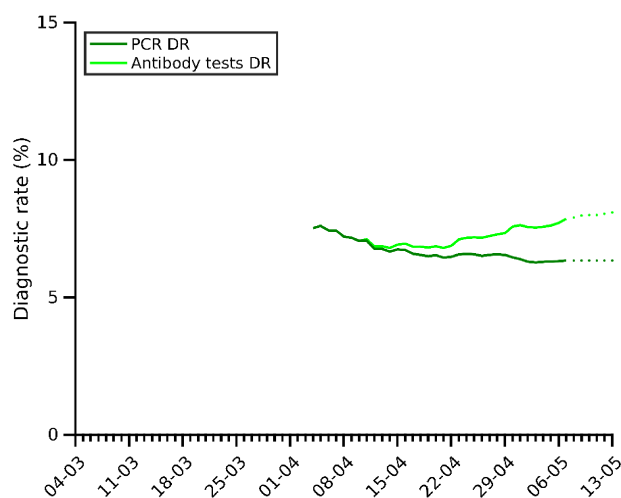
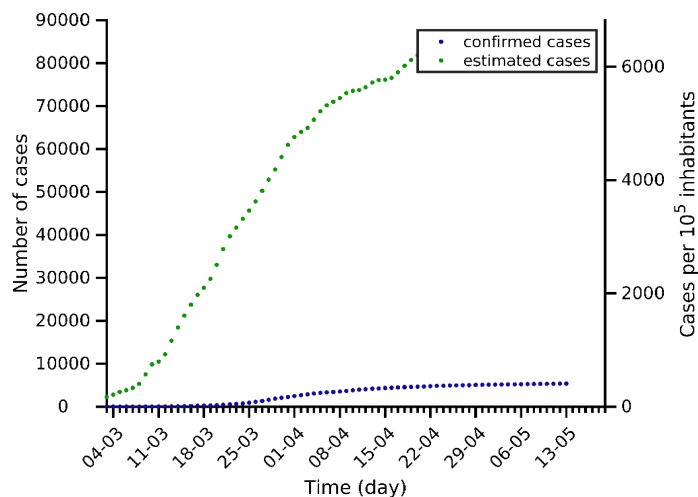
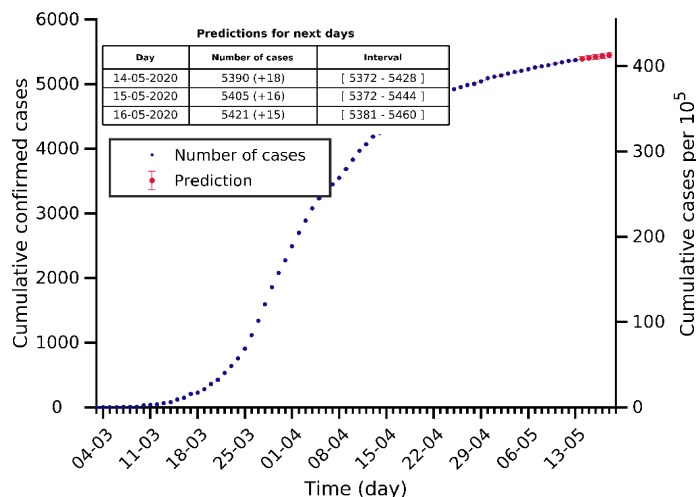
C Valenciana 13-05-2020. Population: 5.0M. Current cumulated incidence: 215/10⁵



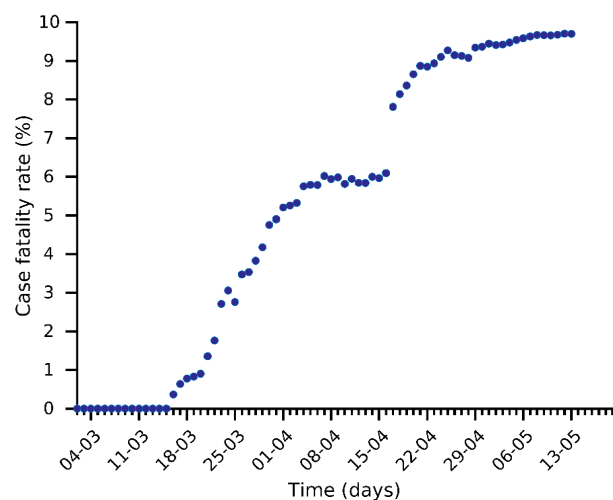
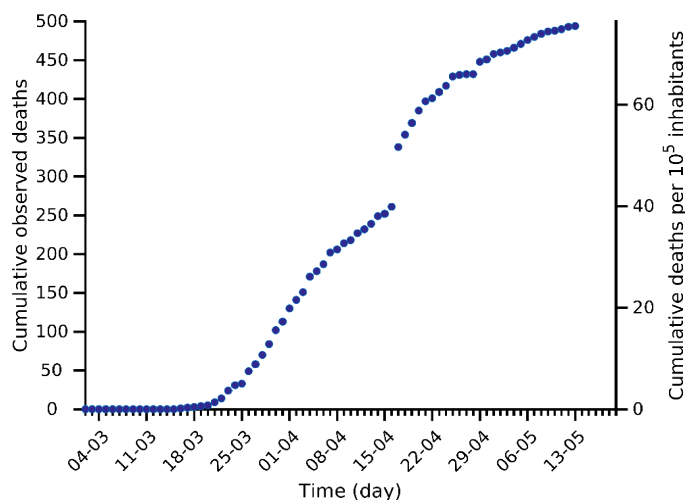
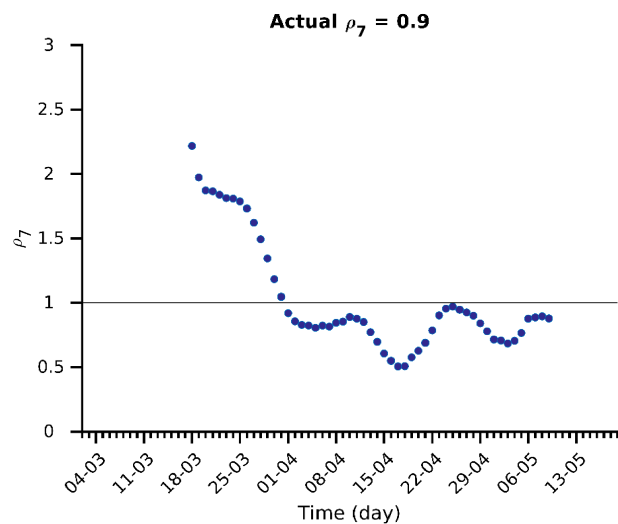
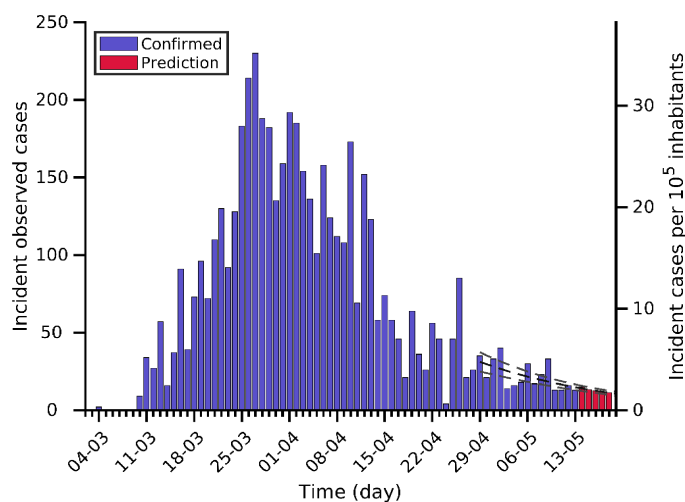
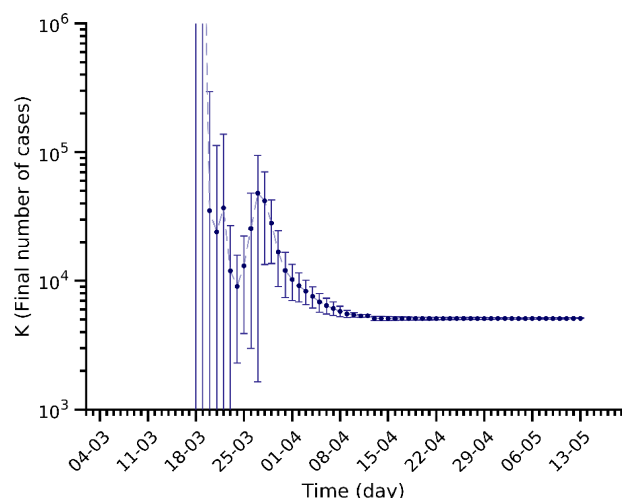
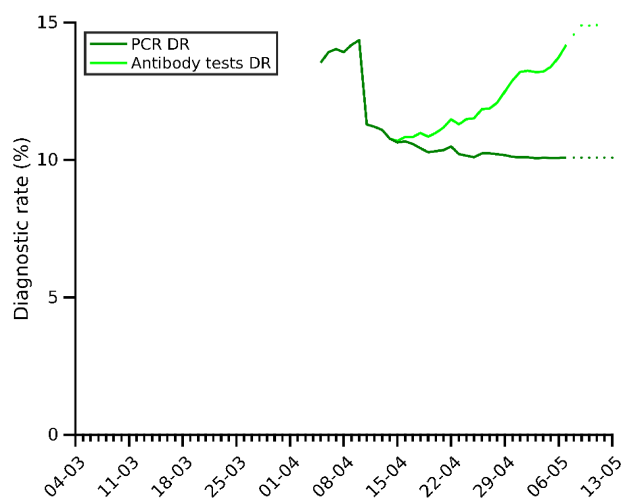
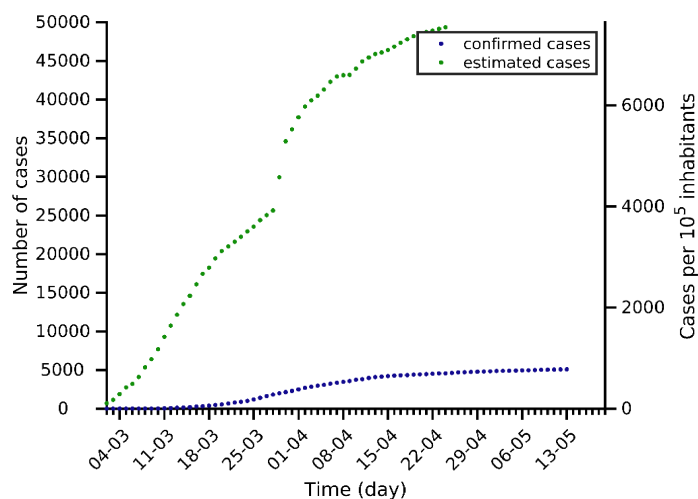
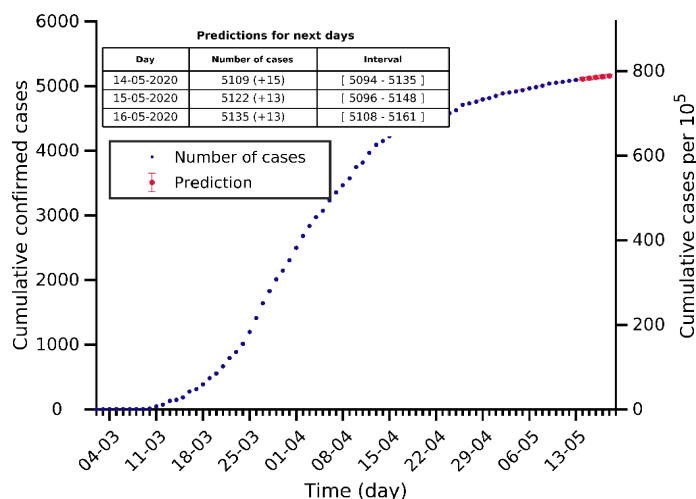
Galicia 13-05-2020. Population: 2.7M. Current cumulated incidence: 345/10⁵



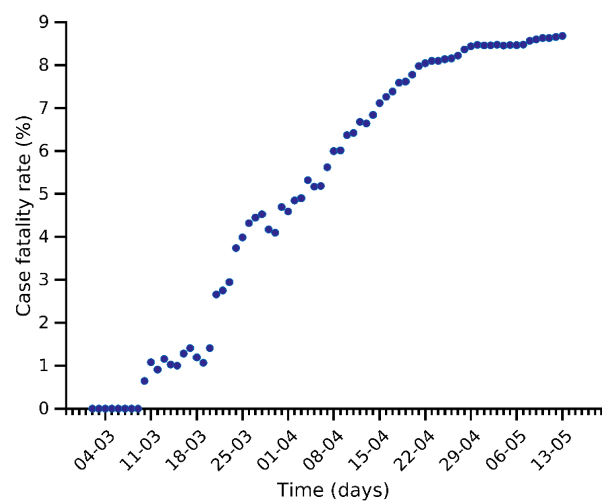
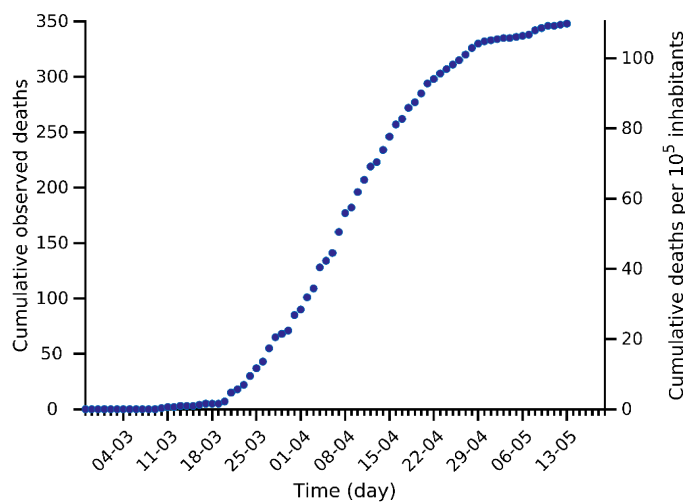
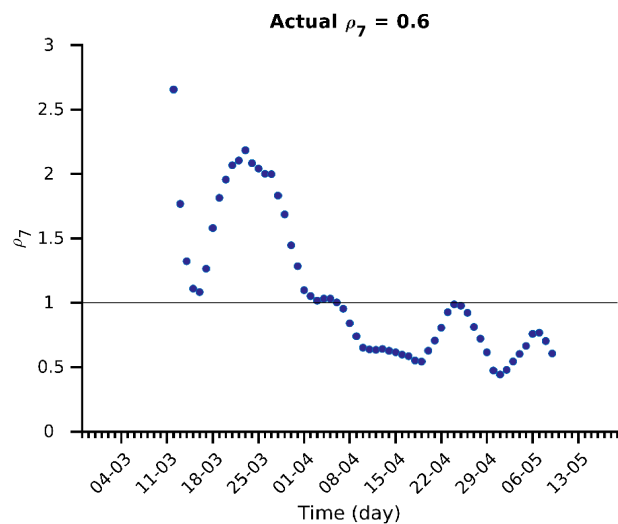
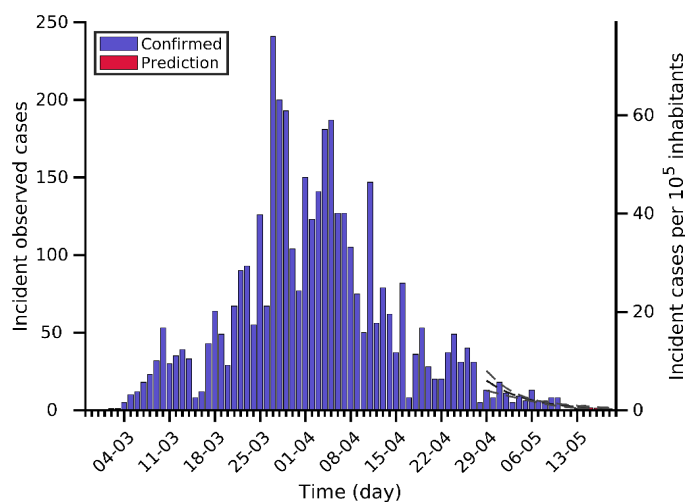
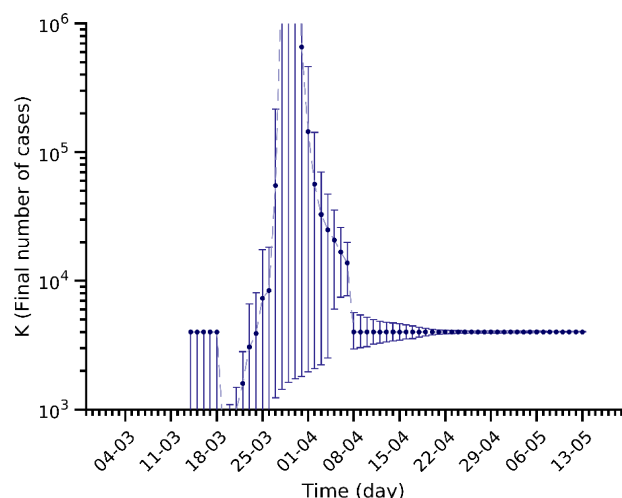
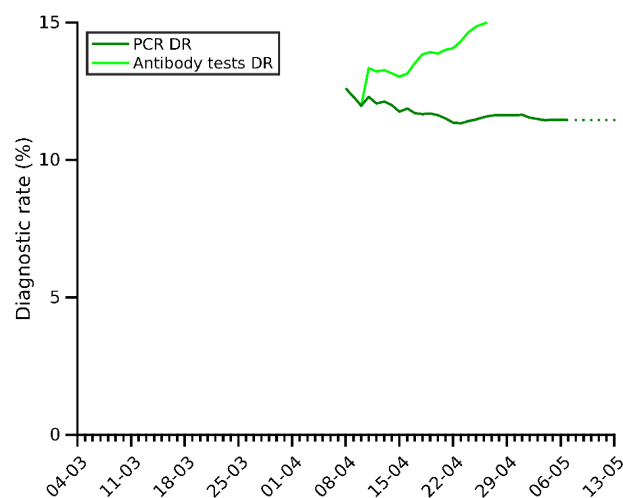
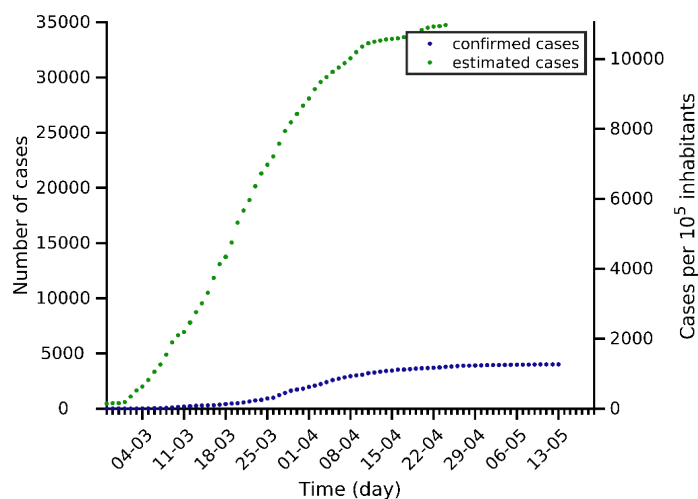
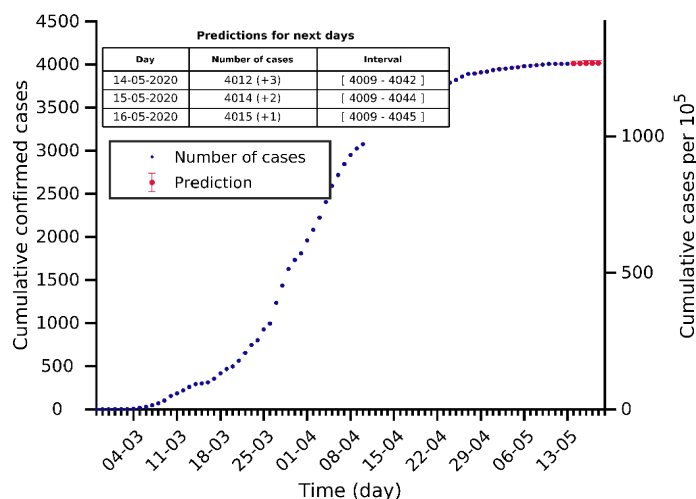
Aragon 13-05-2020. Population: 1.3M. Current cumulated incidence: 407/10⁵



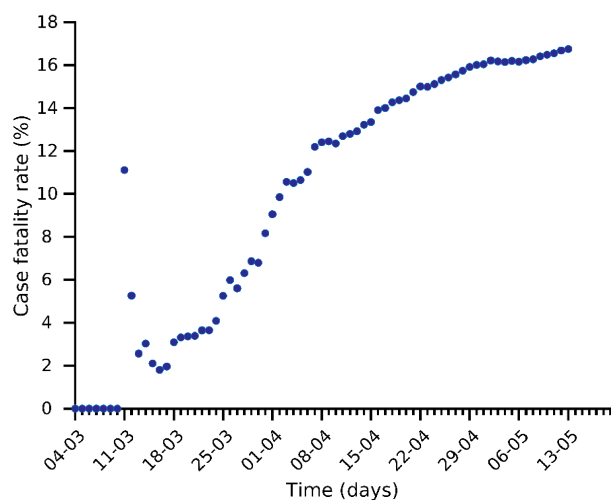
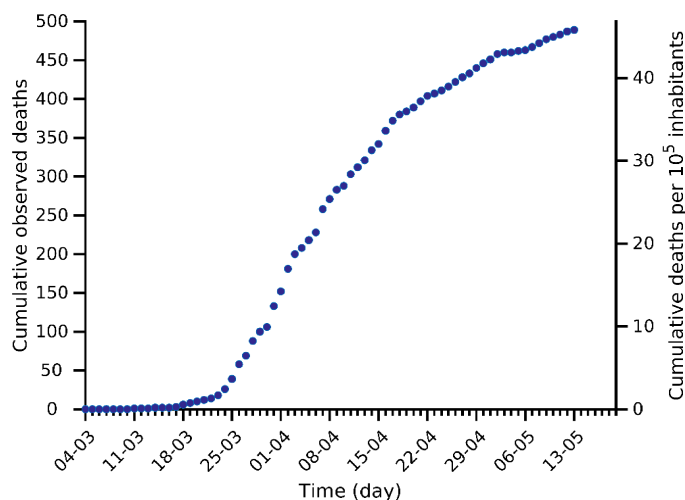
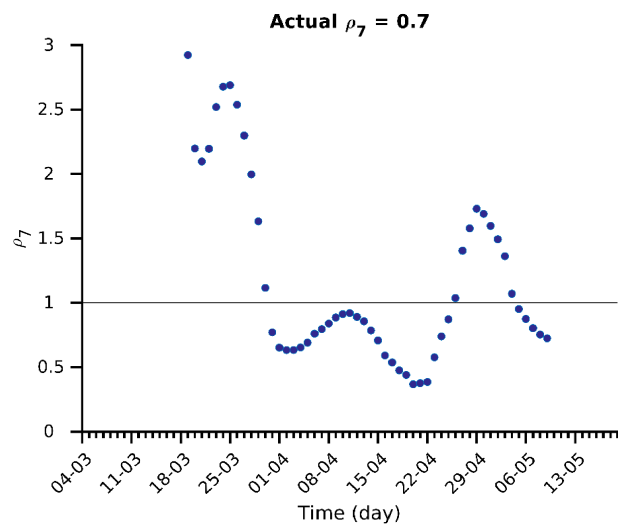
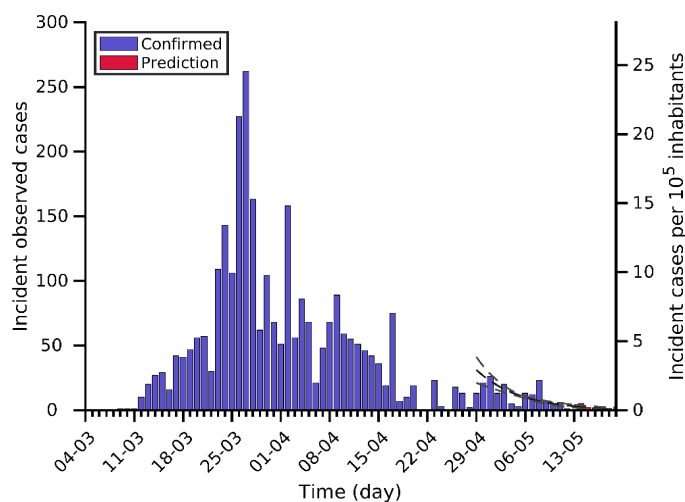
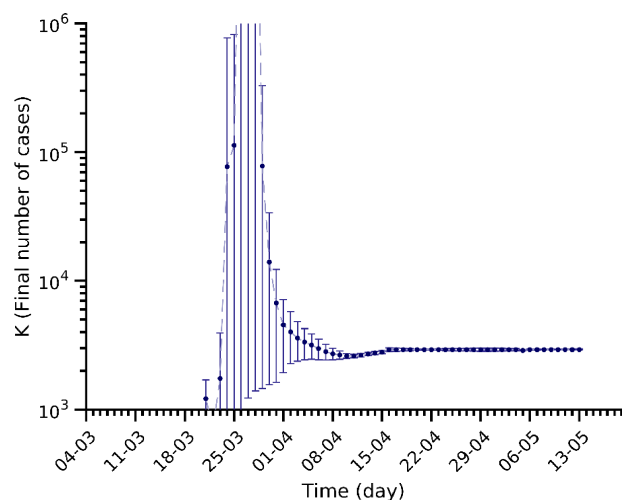
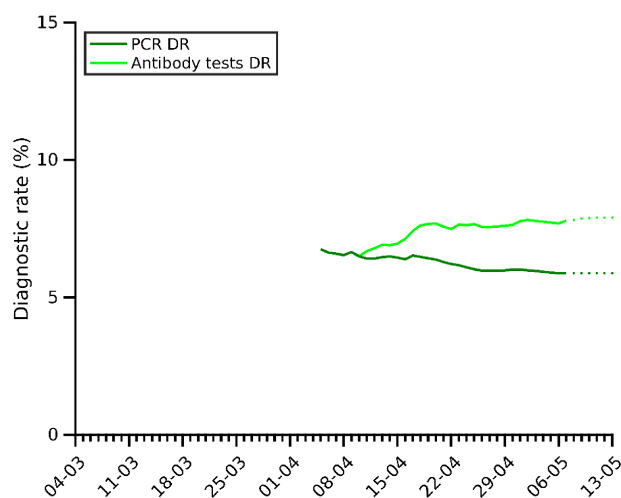
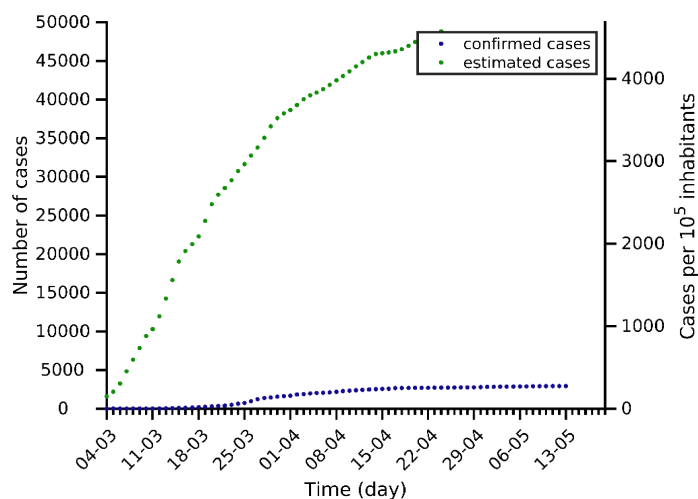
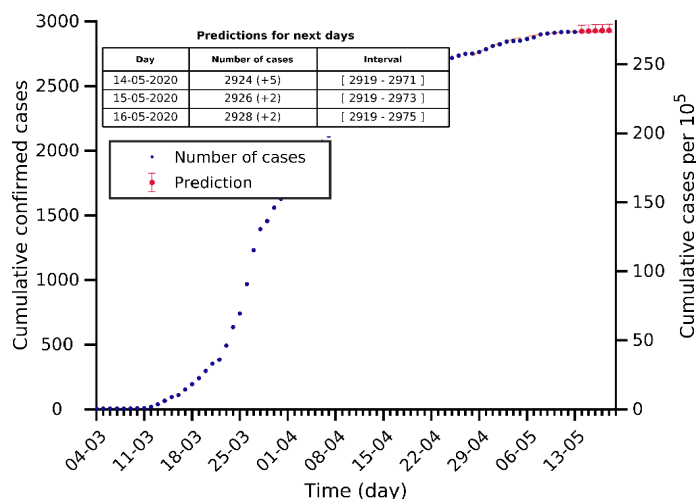
Navarra 13-05-2020. Population: 0.7M. Current cumulated incidence: 779/10⁵



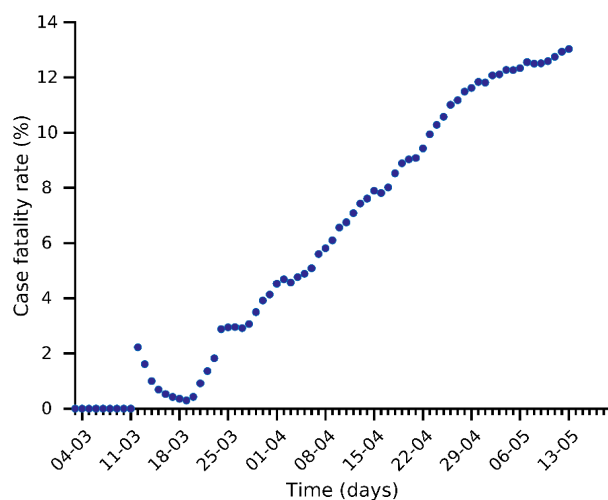
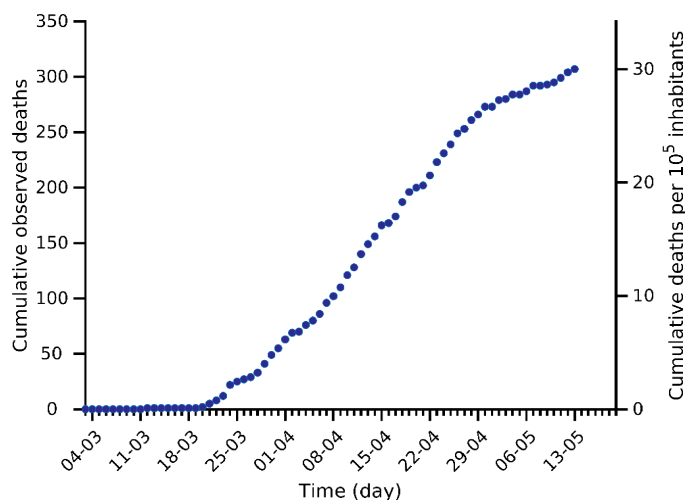
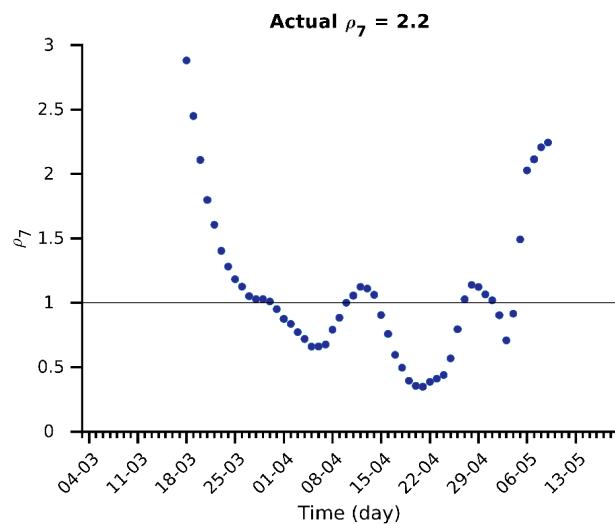
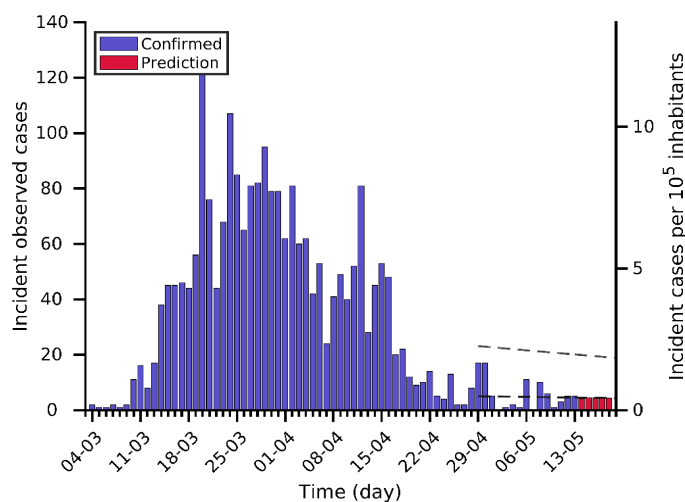
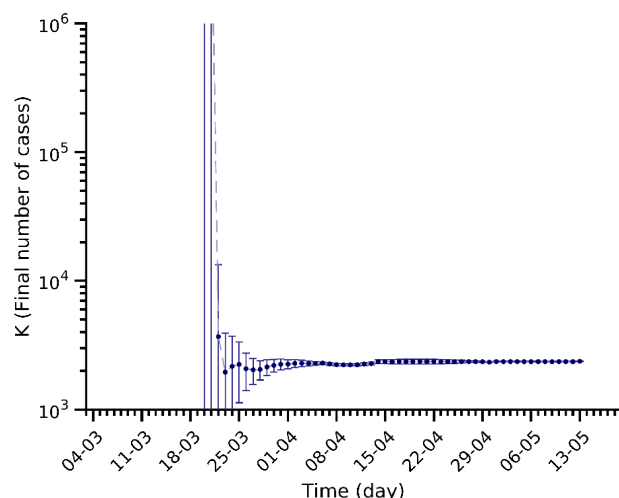
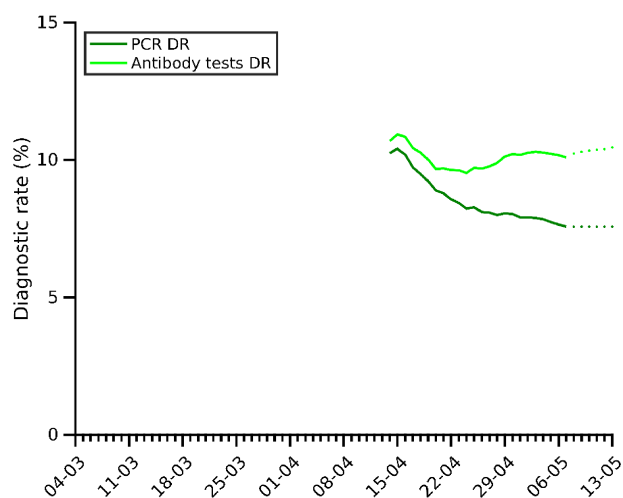
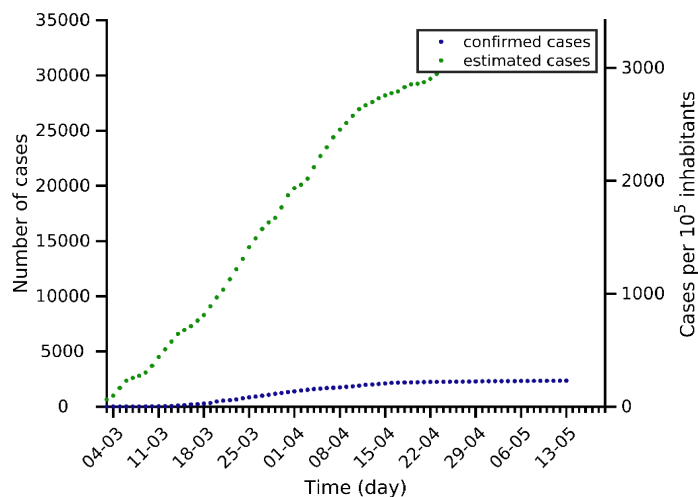
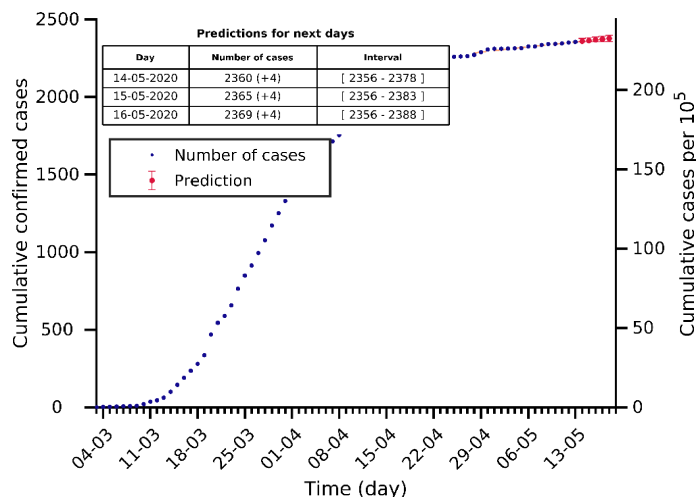
La Rioja 13-05-2020. Population: 0.3M. Current cumulated incidence: 1265/10⁵



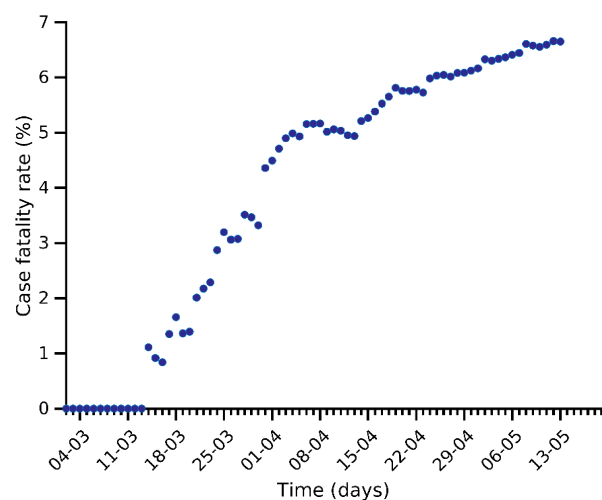
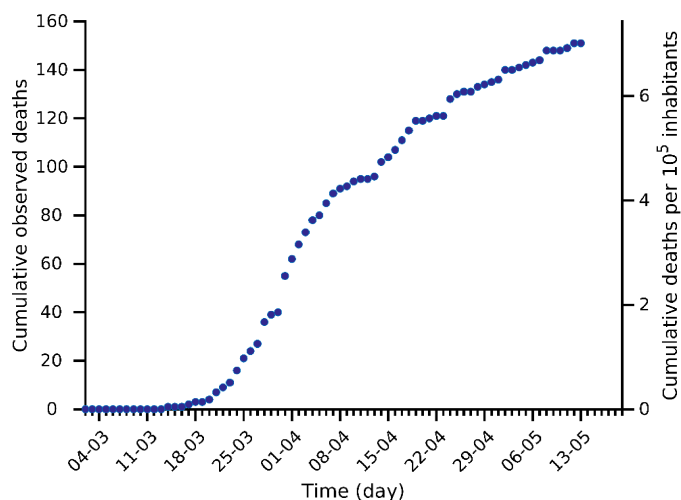
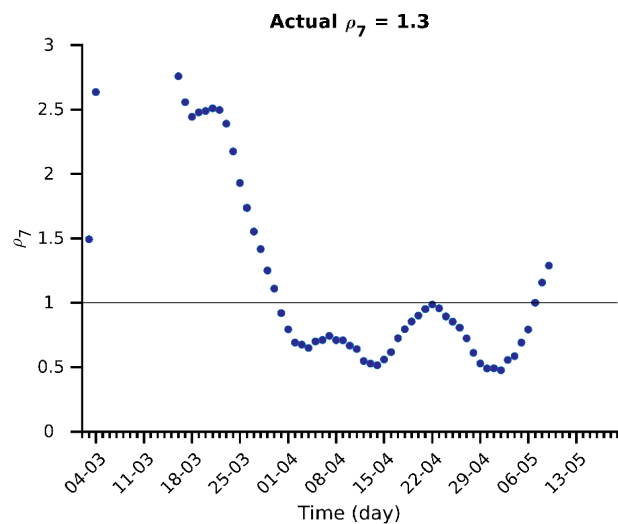
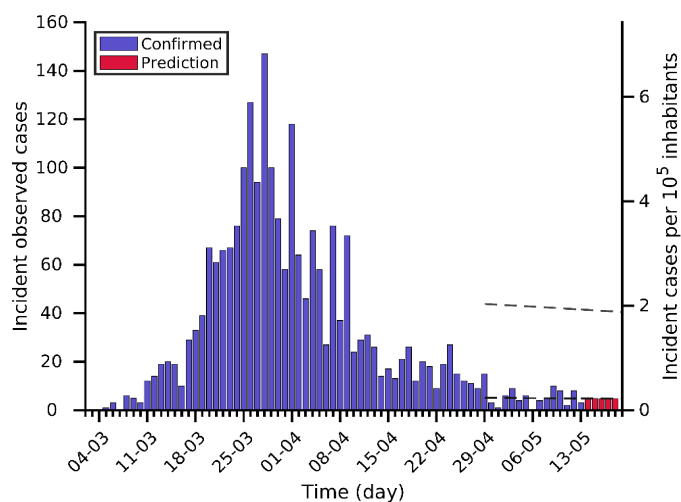
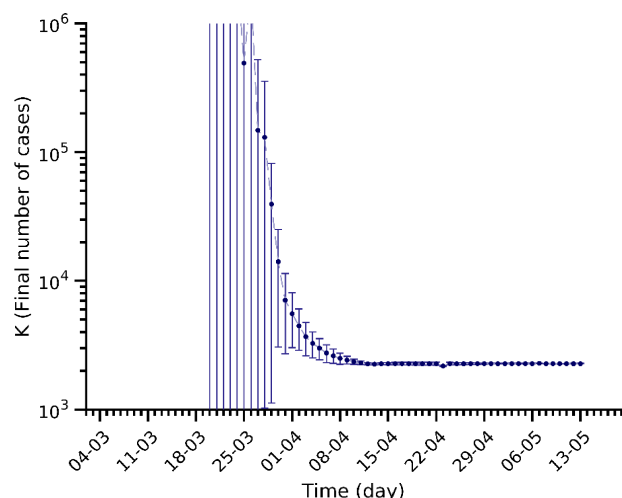
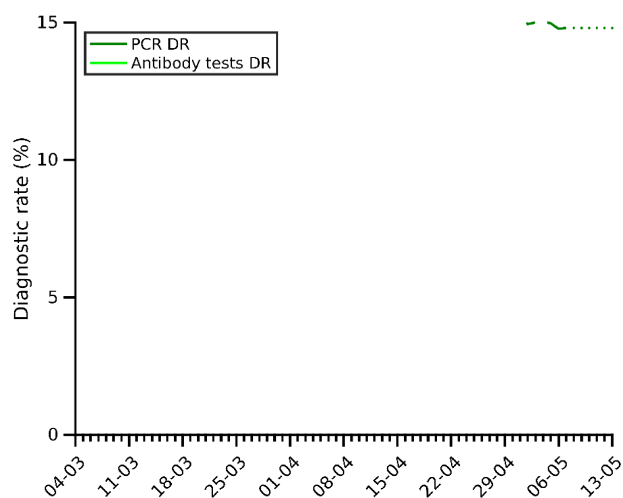
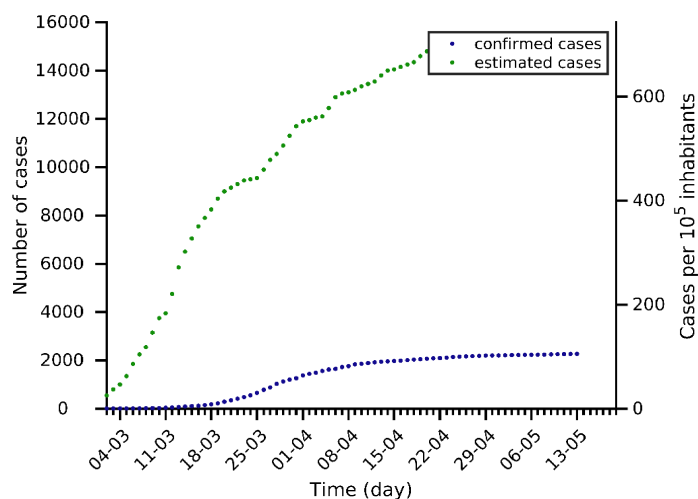
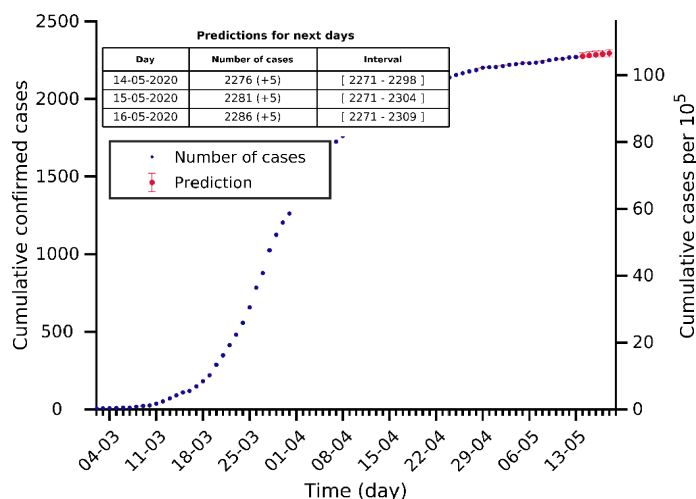
Extremadura 13-05-2020. Population: 1.1M. Current cumulated incidence: 273/10⁵



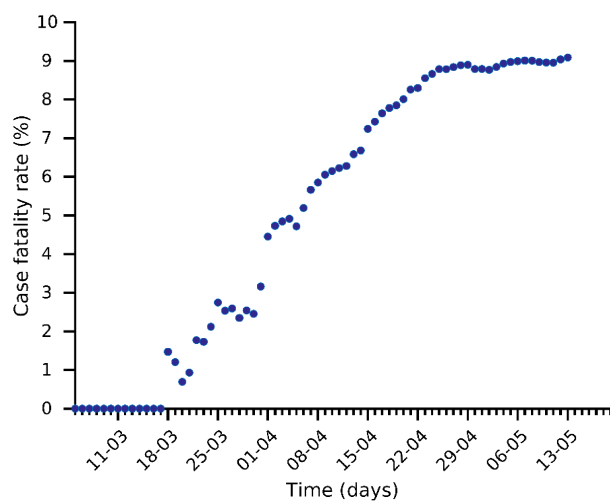
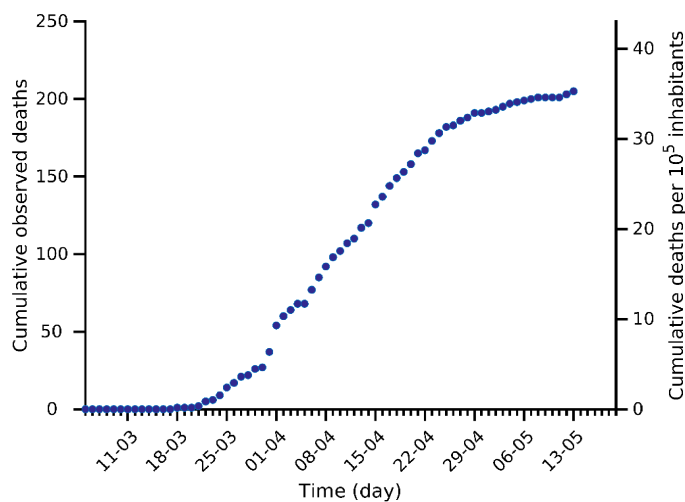
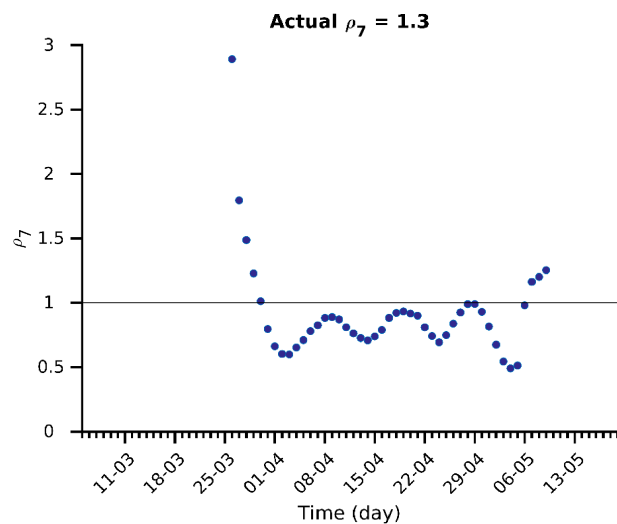
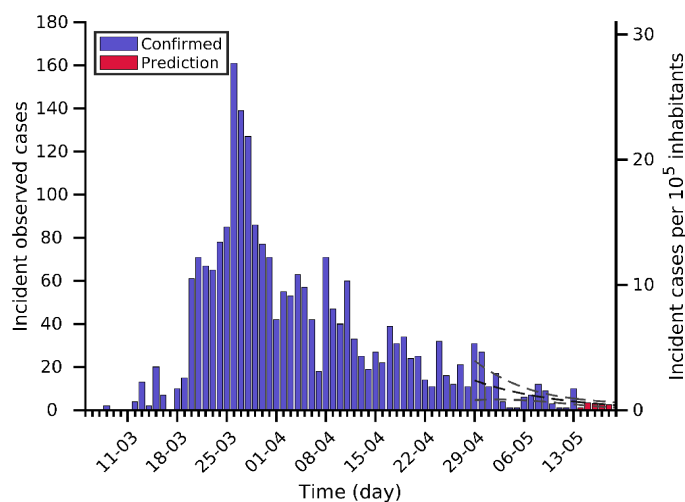
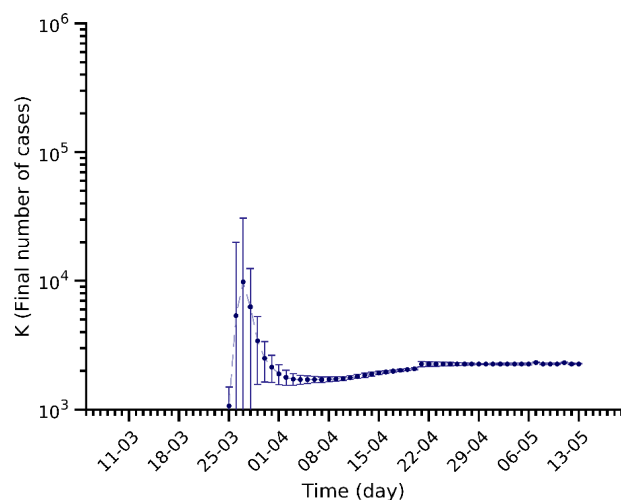
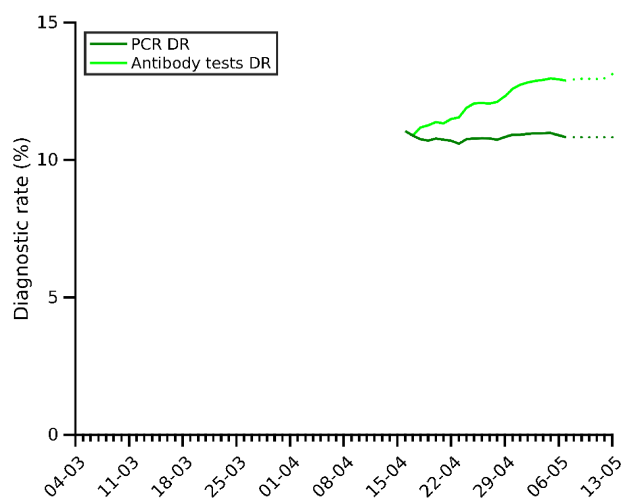
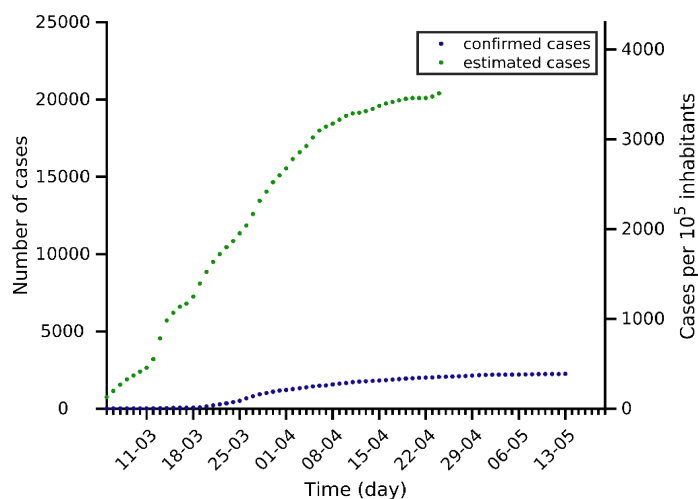
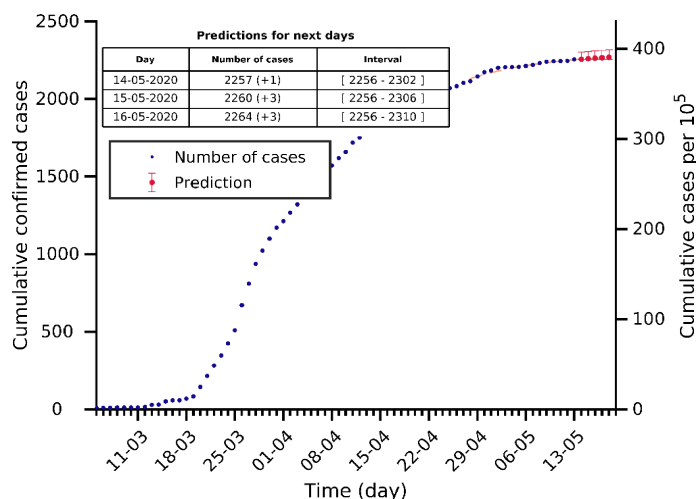
Asturias 13-05-2020. Population: 1.0M. Current cumulated incidence: 230/10⁵



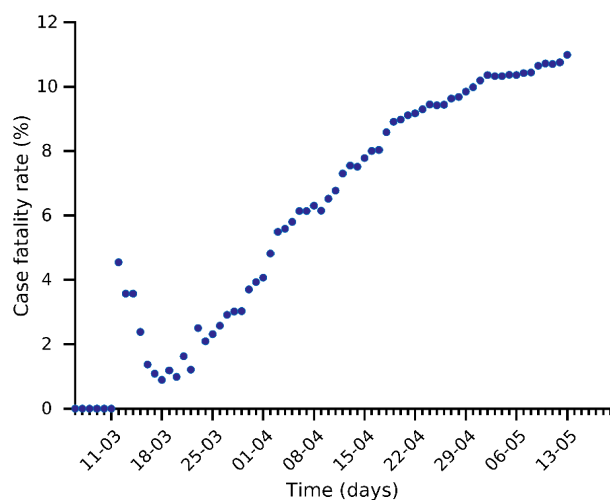
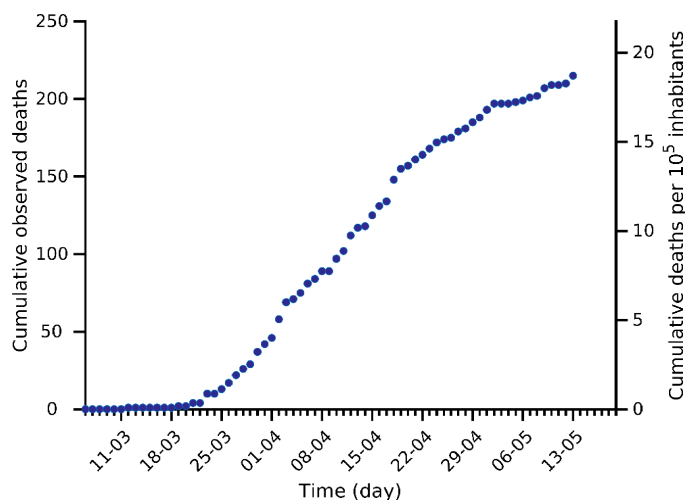
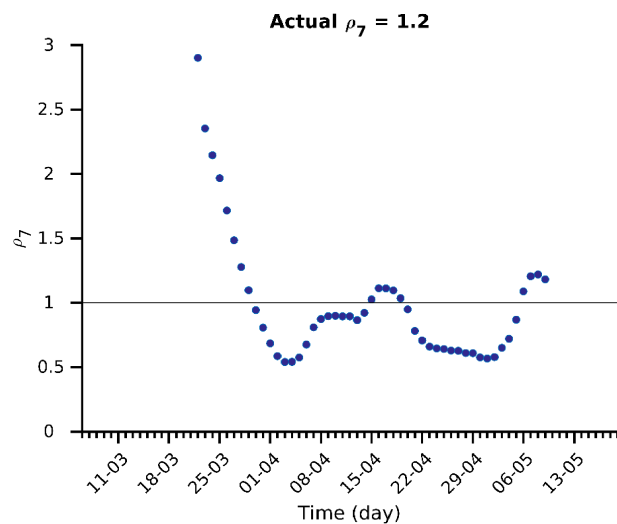
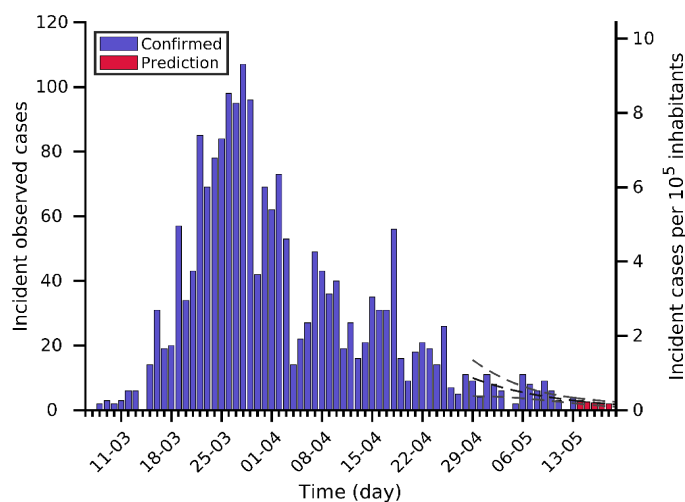
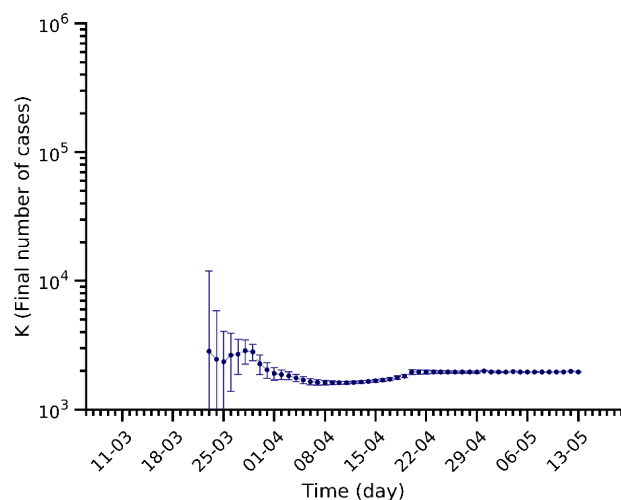
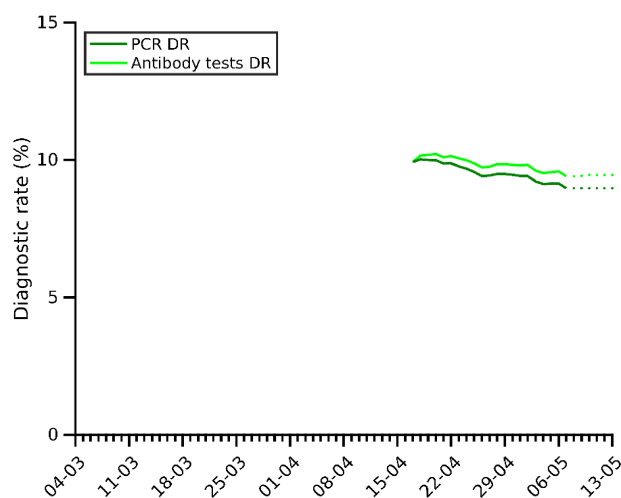
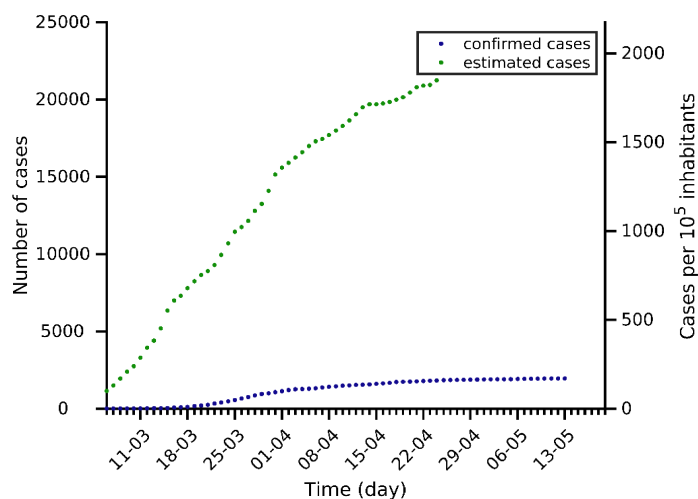
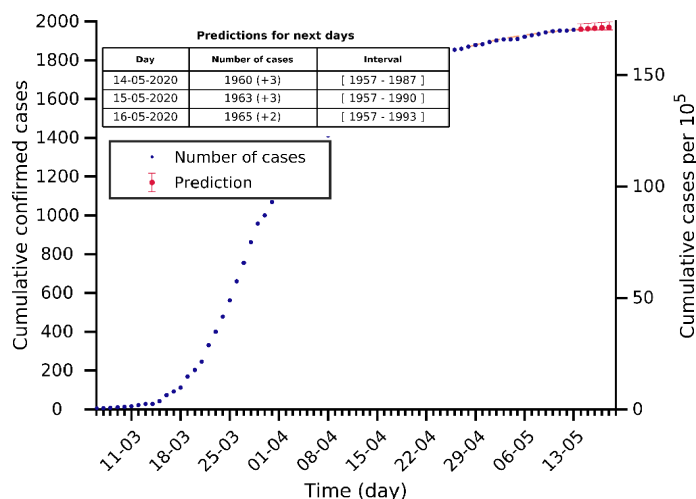
Canarias 13-05-2020. Population: 2.2M. Current cumulated incidence: 105/10⁵



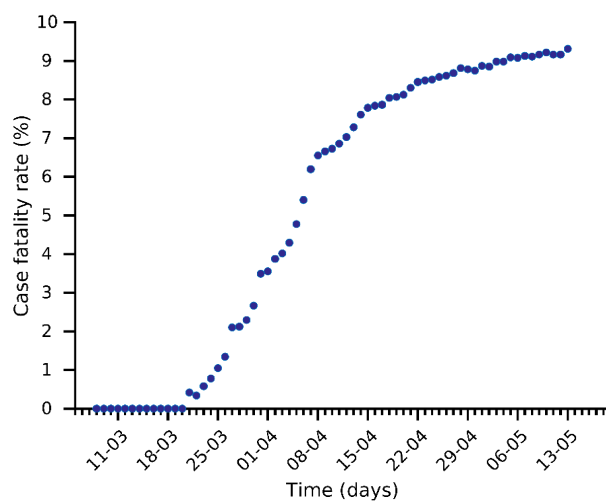
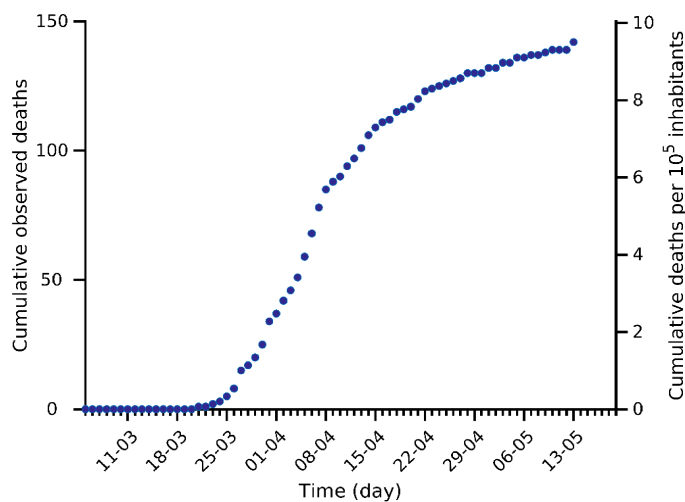
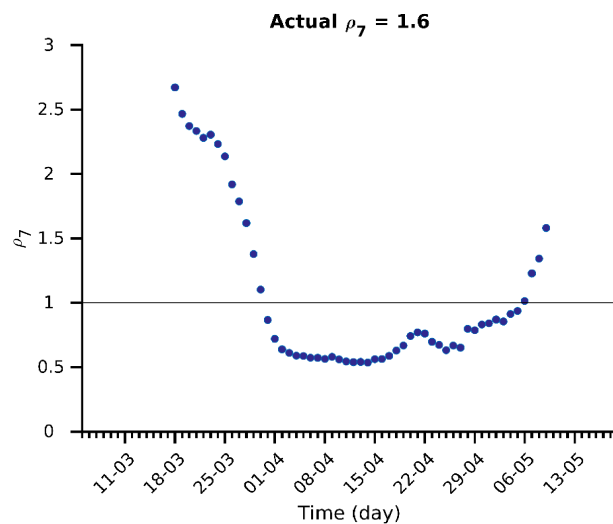
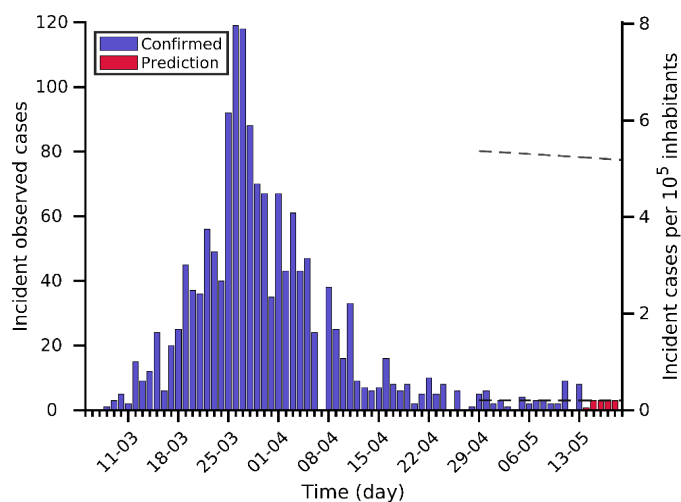
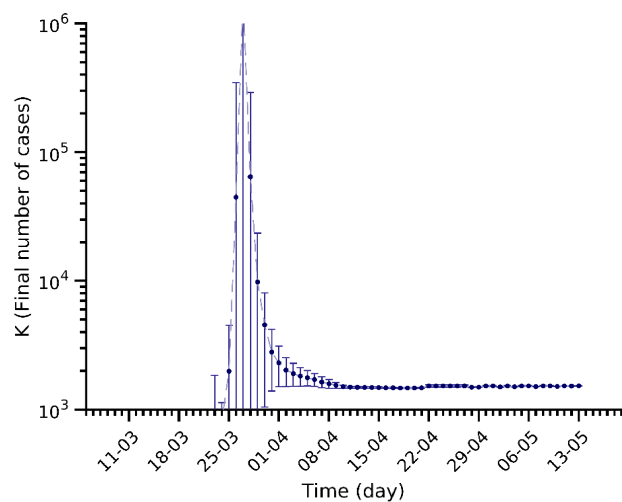
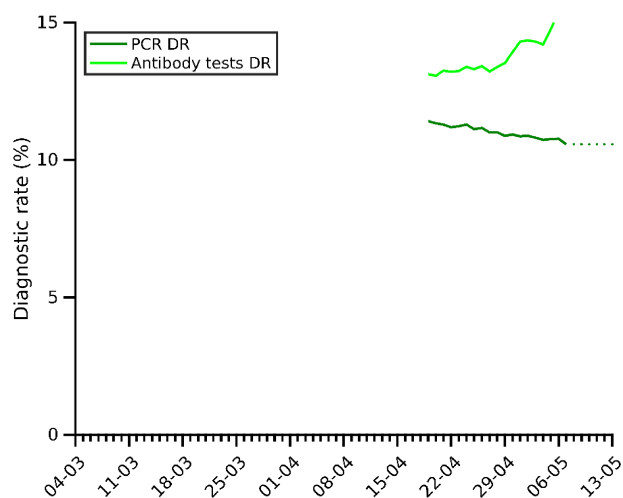
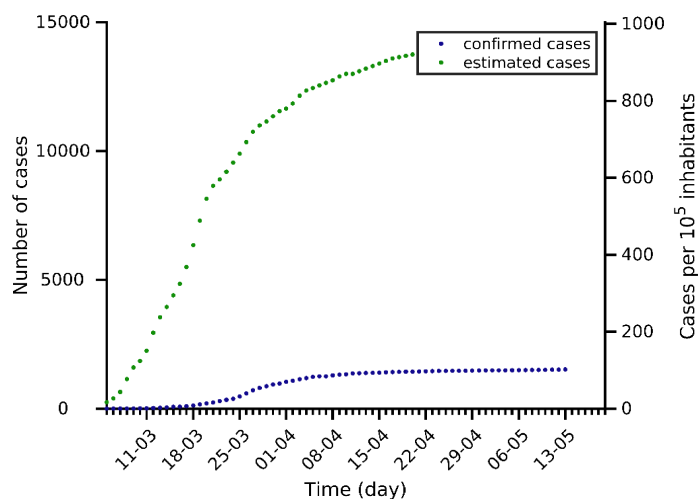
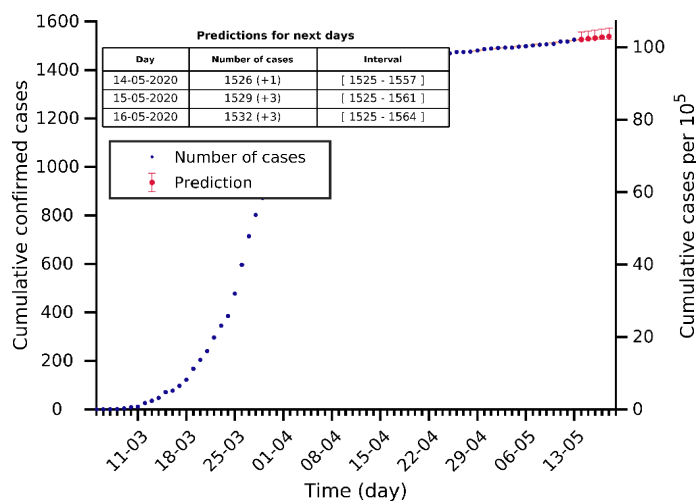
Cantabria 13-05-2020. Population: 0.6M. Current cumulated incidence: 388/10⁵



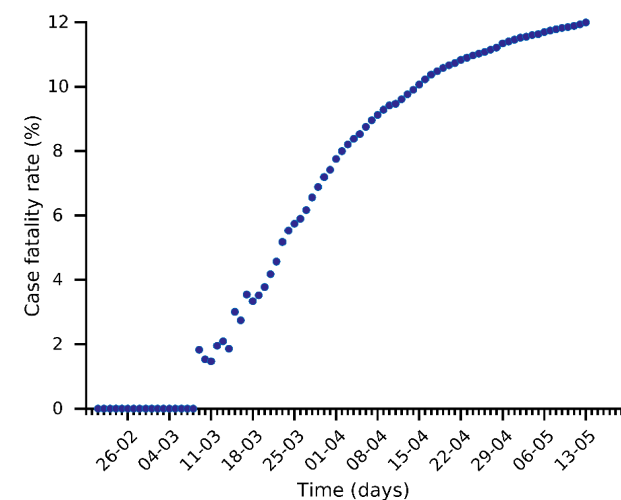
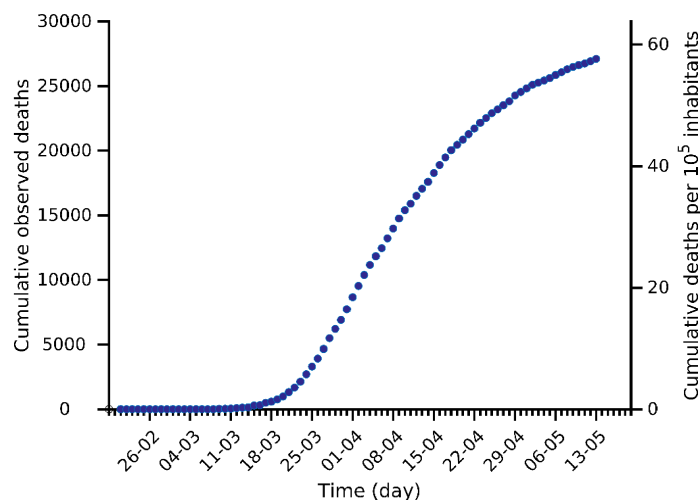
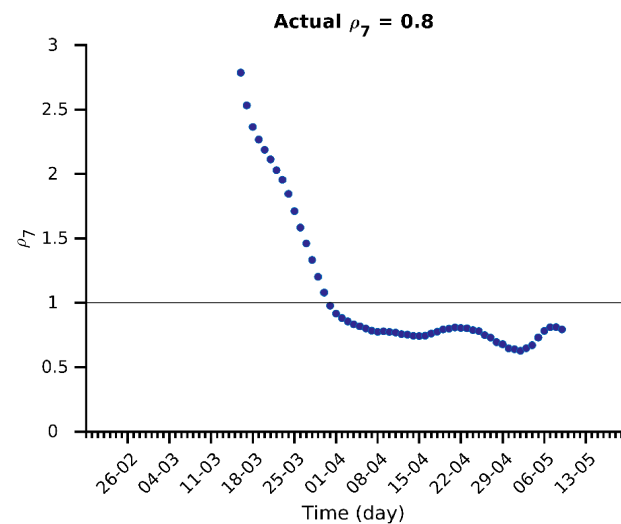
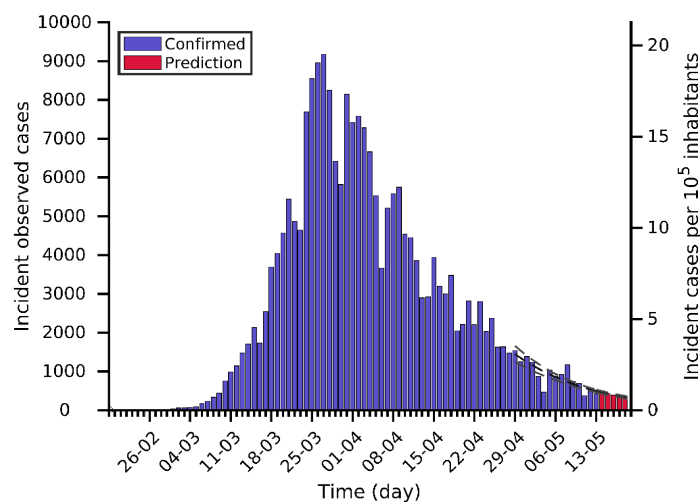
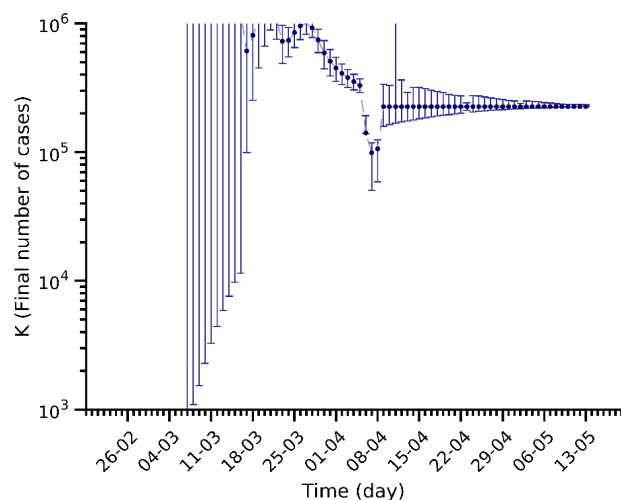
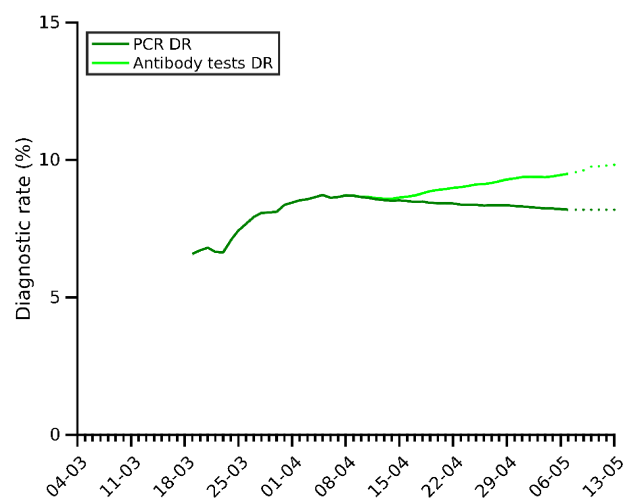
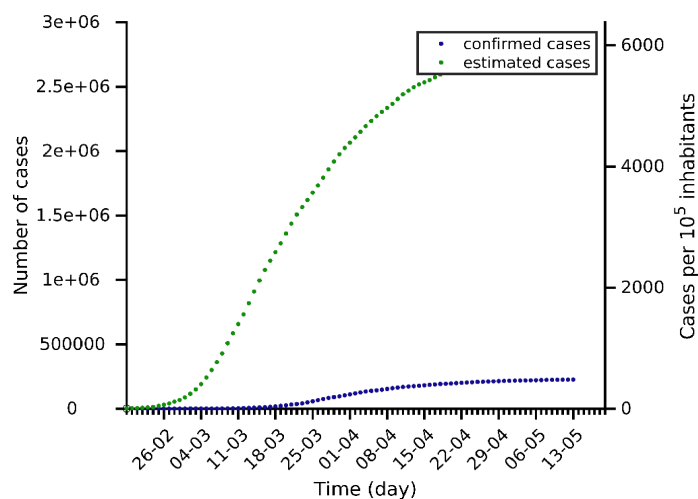
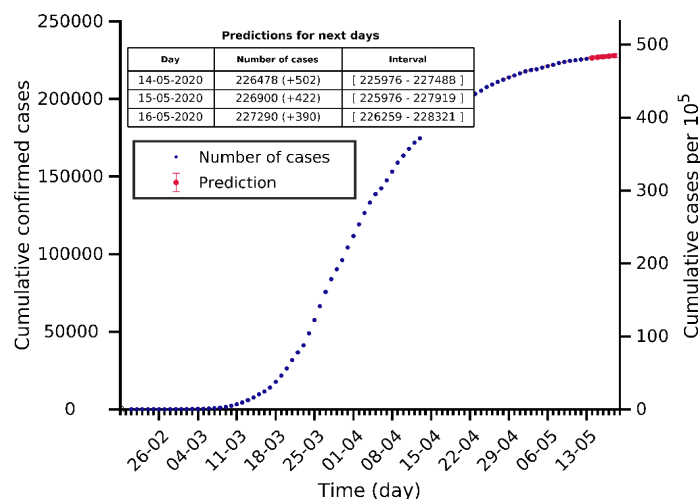
Baleares 13-05-2020. Population: 1.1M. Current cumulated incidence: 170/10⁵



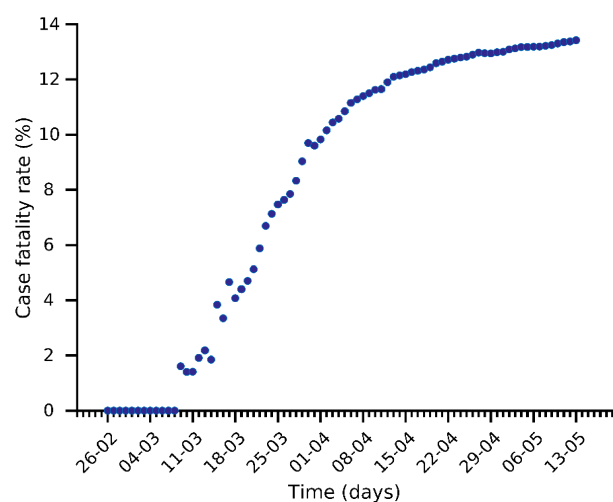
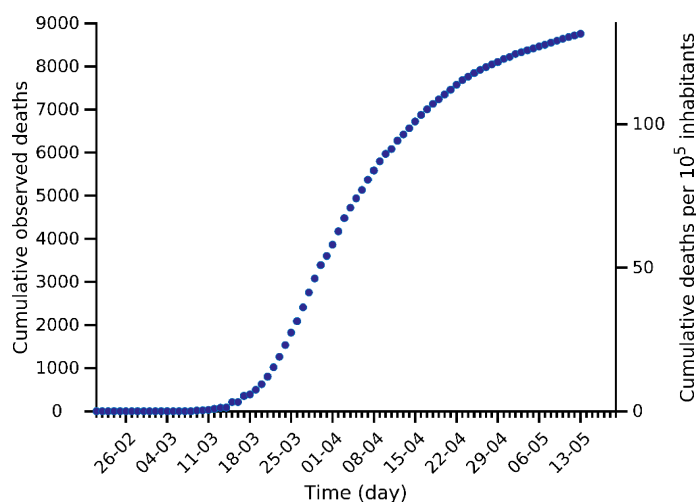
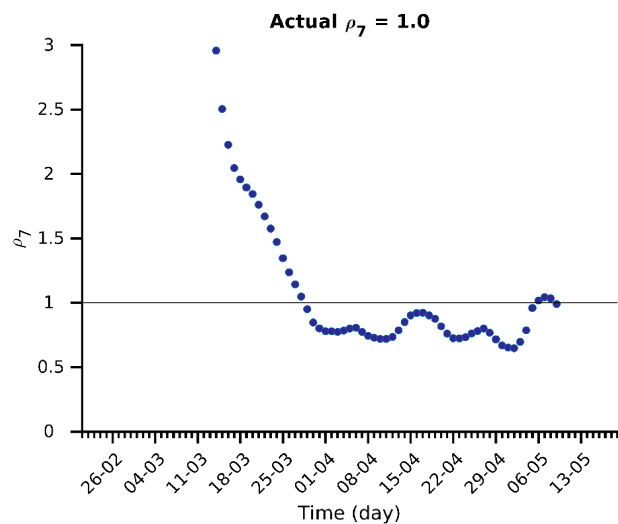
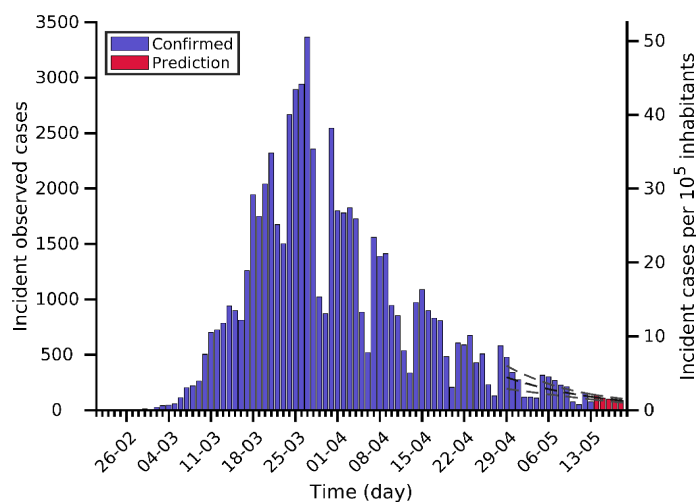
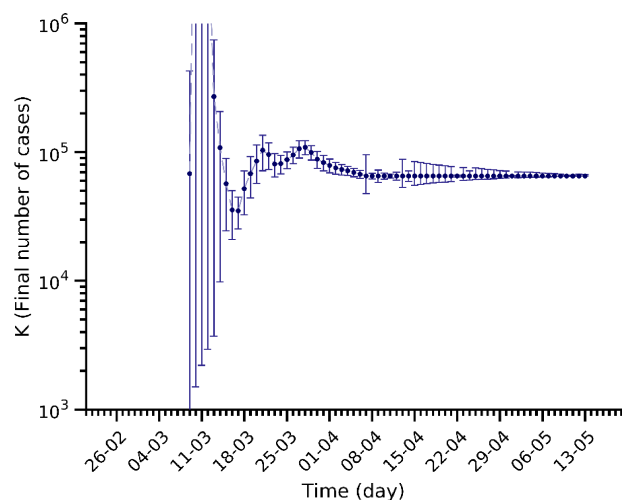
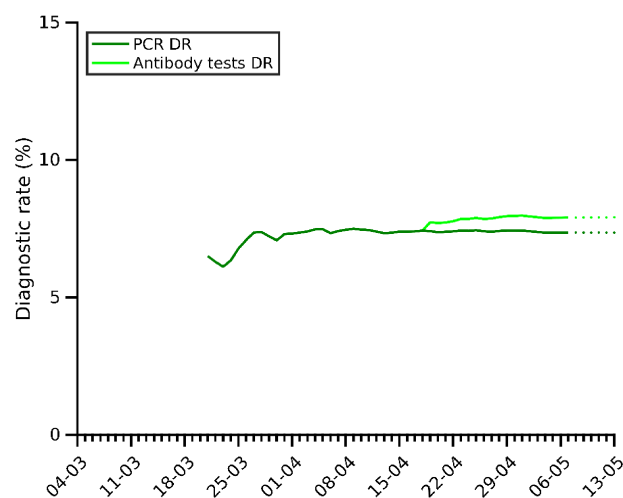
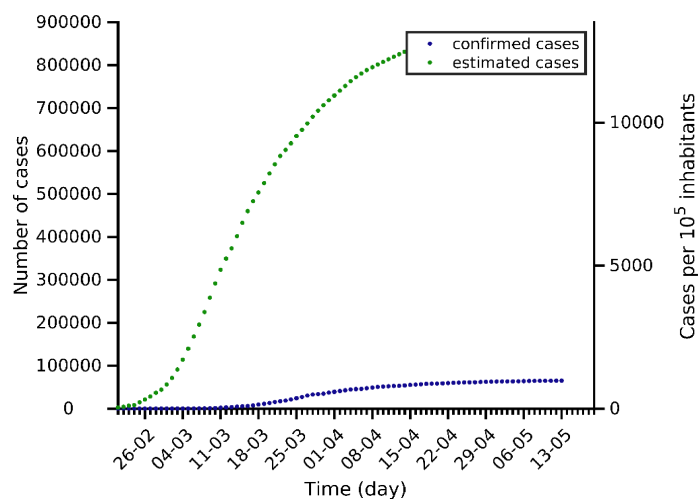
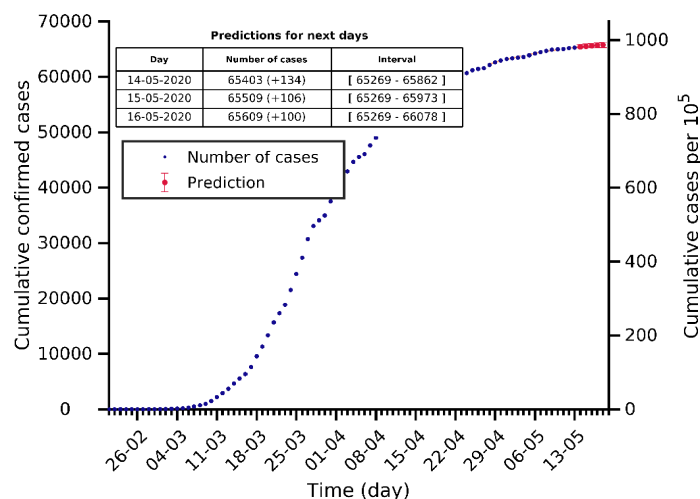
Murcia 13-05-2020. Population: 1.5M. Current cumulated incidence: 102/10⁵



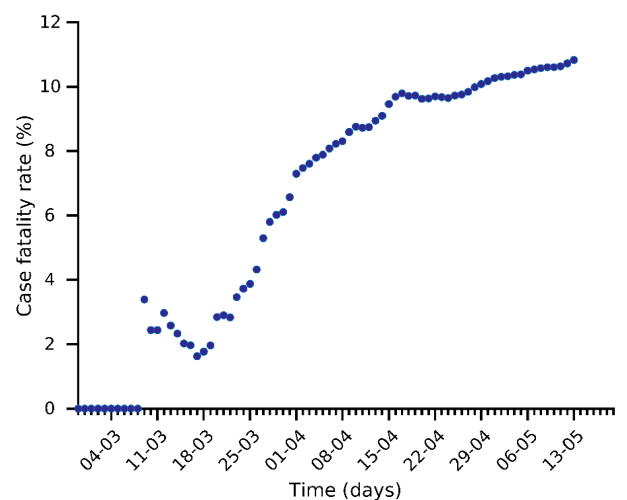
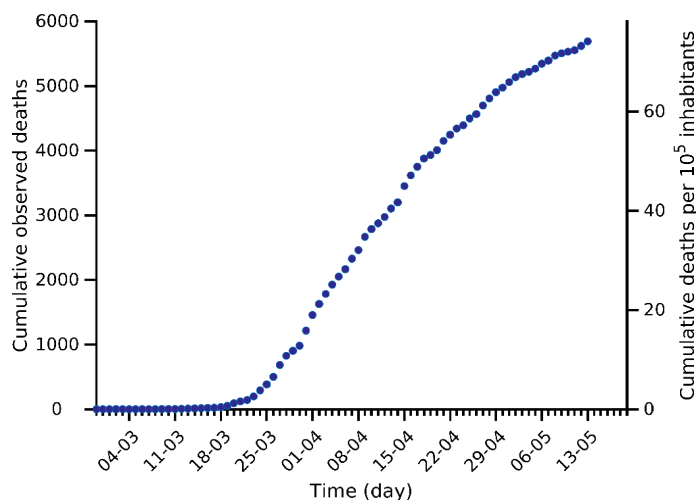
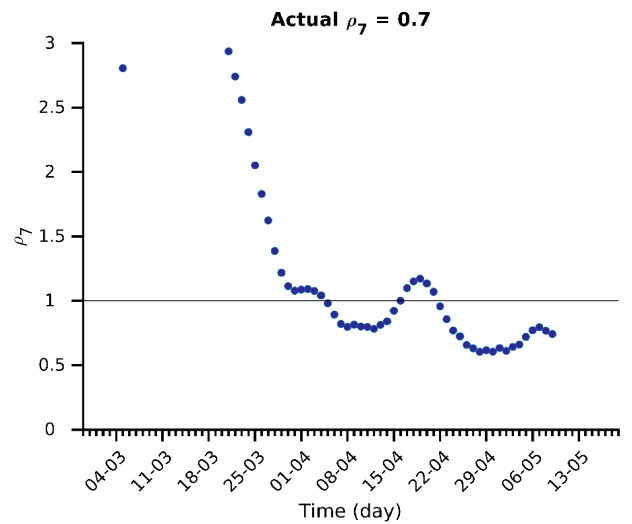
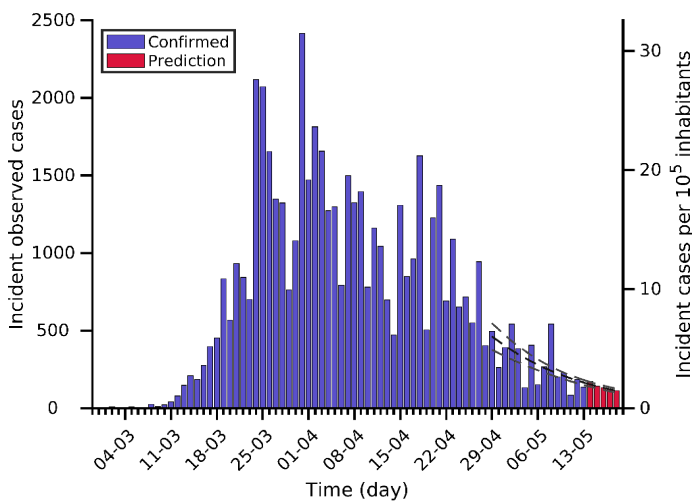
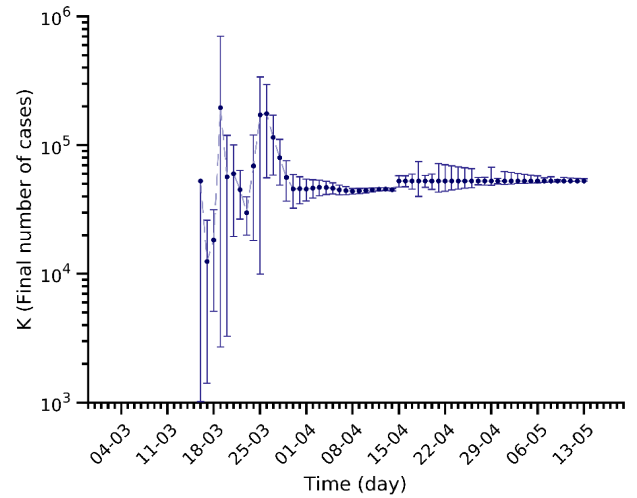
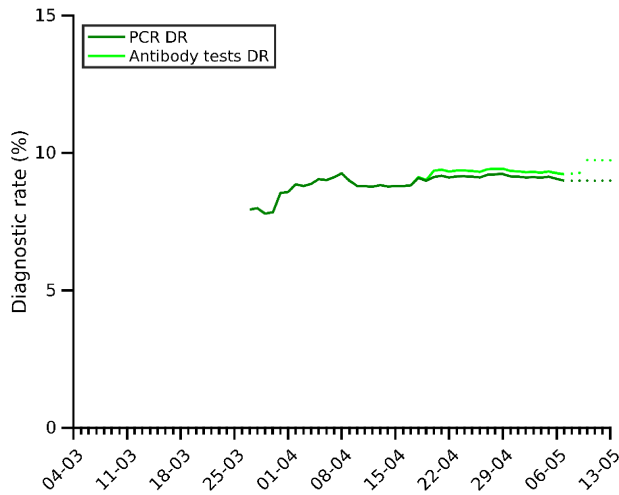
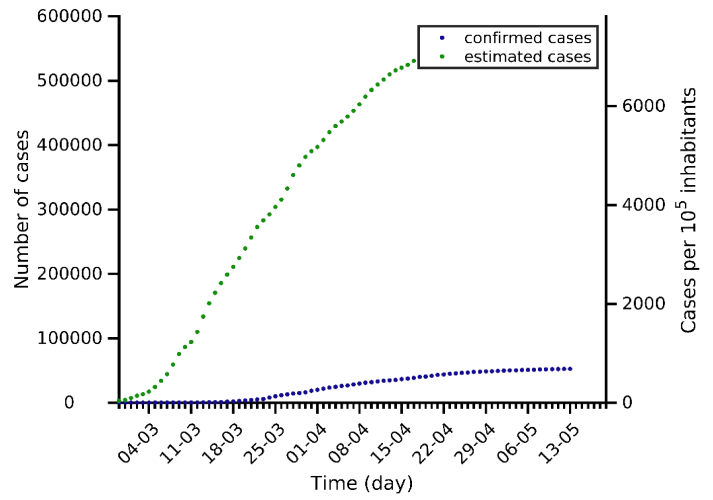
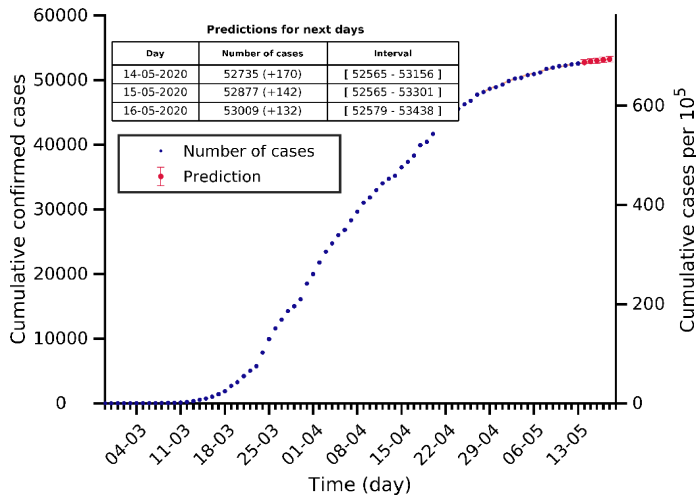
Spain 13-05-2020. Population: 47.0M. Current cumulated incidence: 481/10⁵



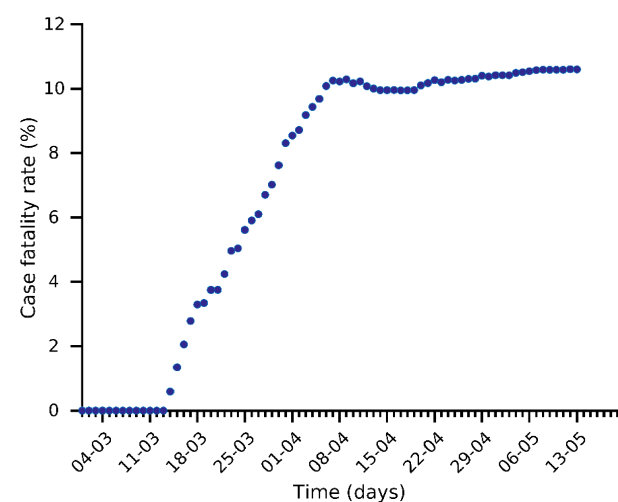
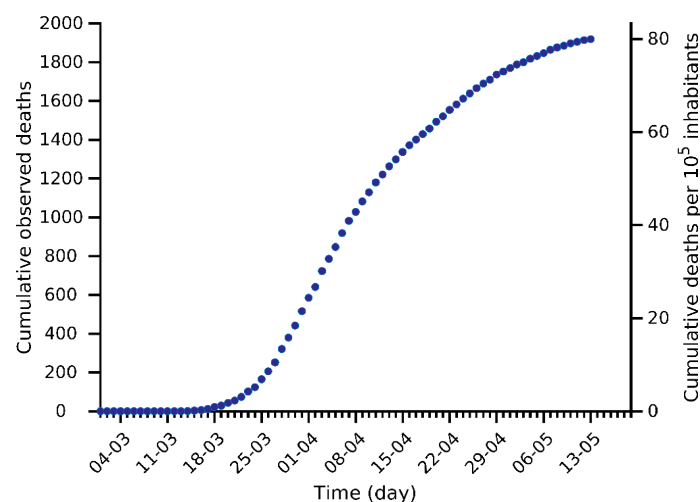
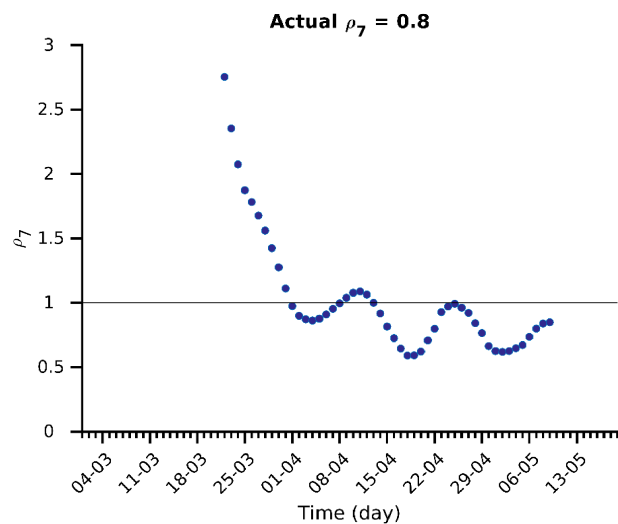
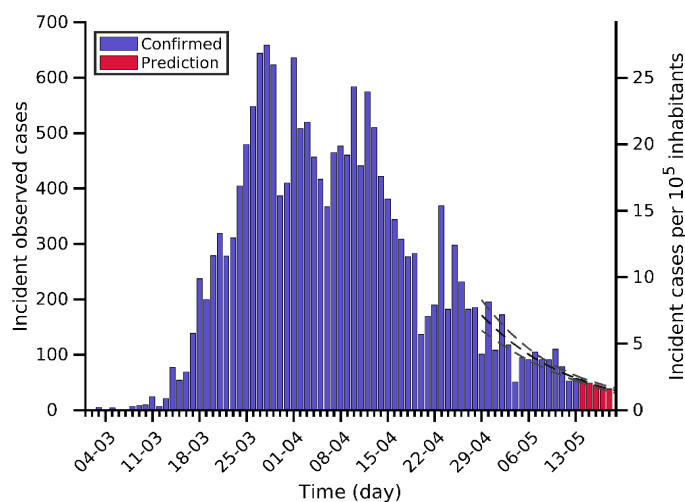
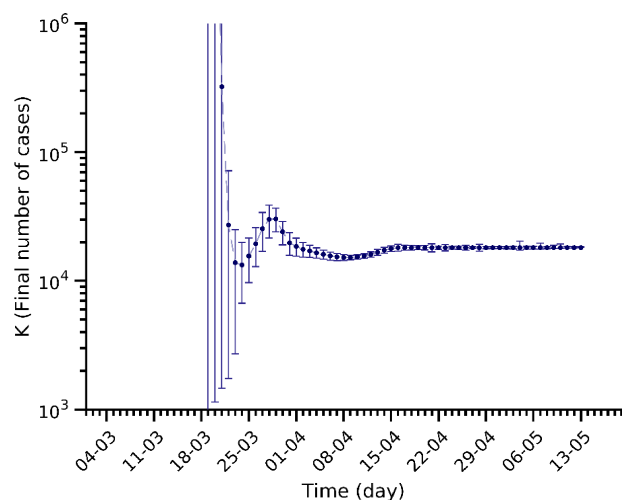
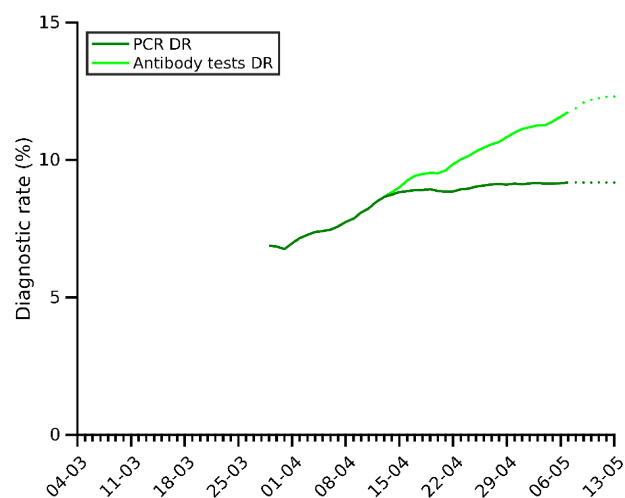
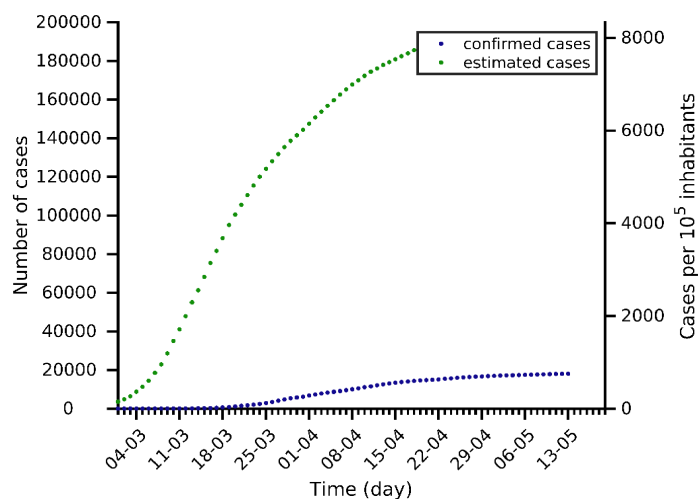
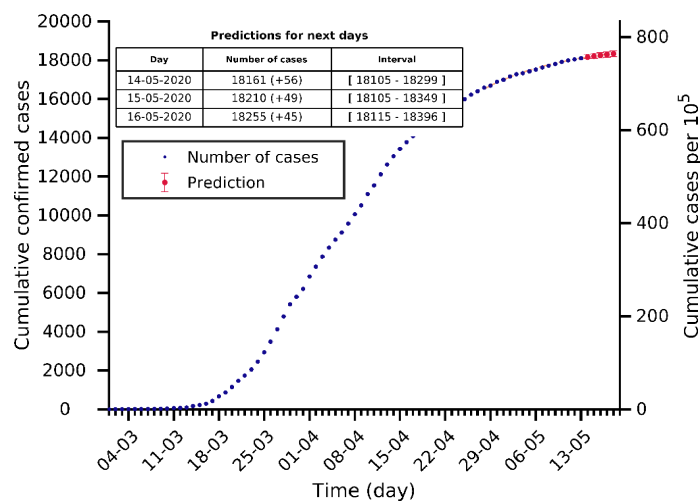
Madrid 13-05-2020. Population: 6.7M. Current cumulated incidence: 980/10⁵



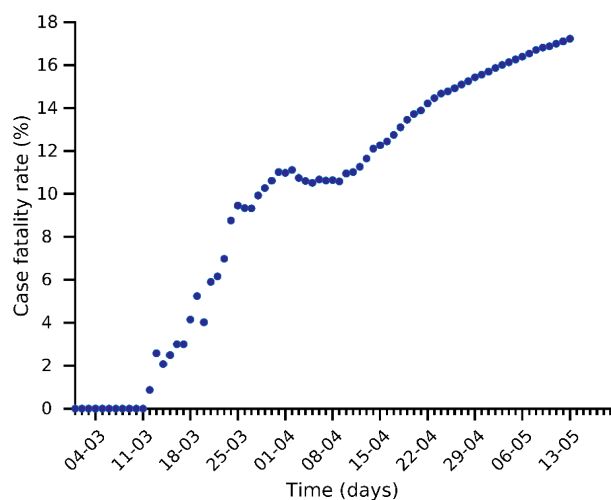
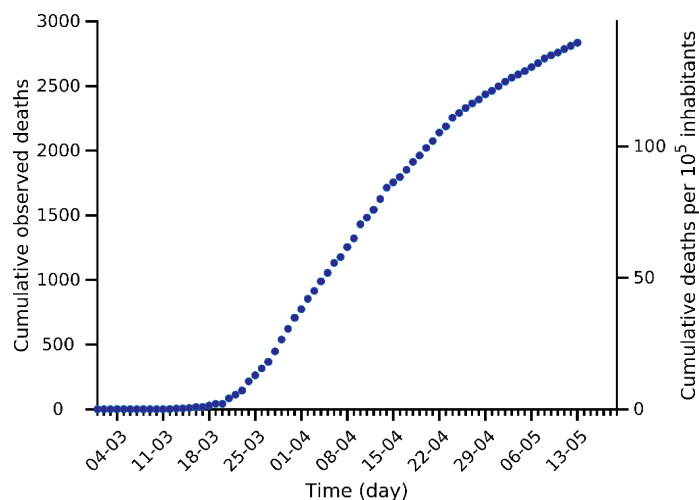
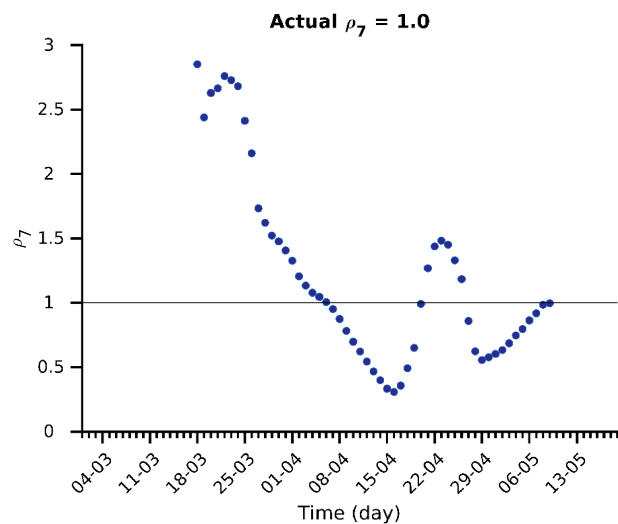
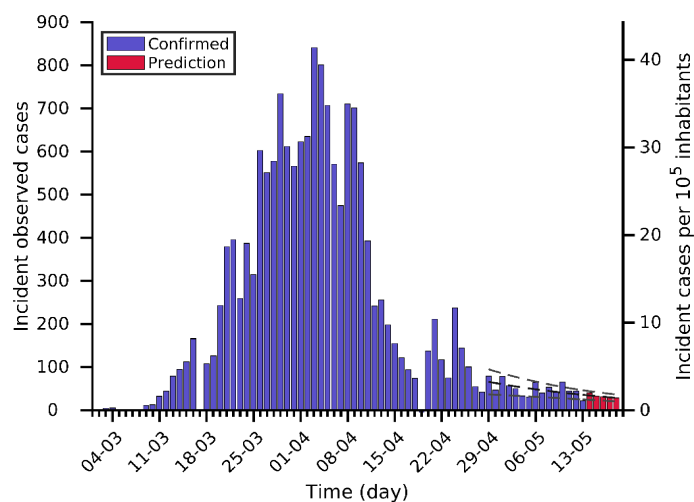
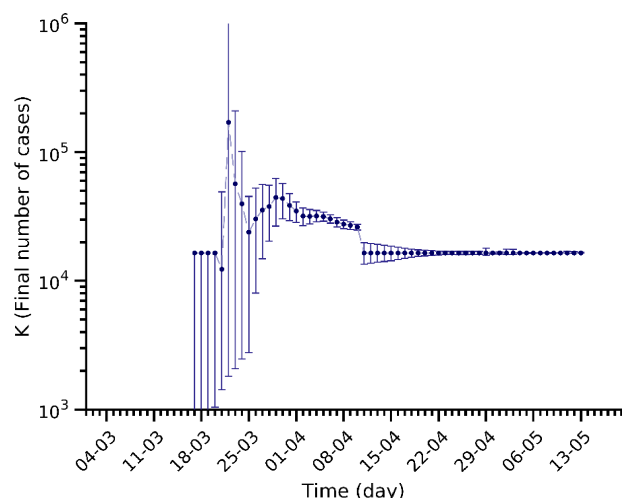
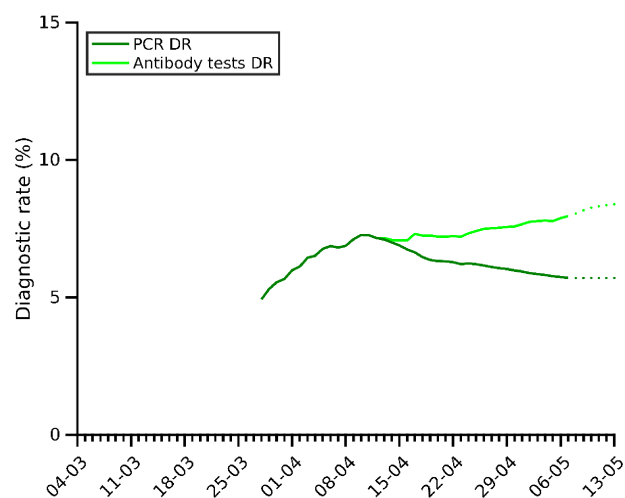
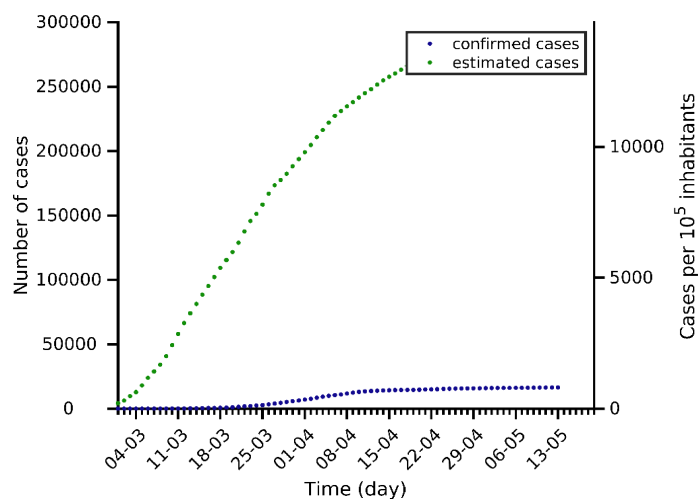
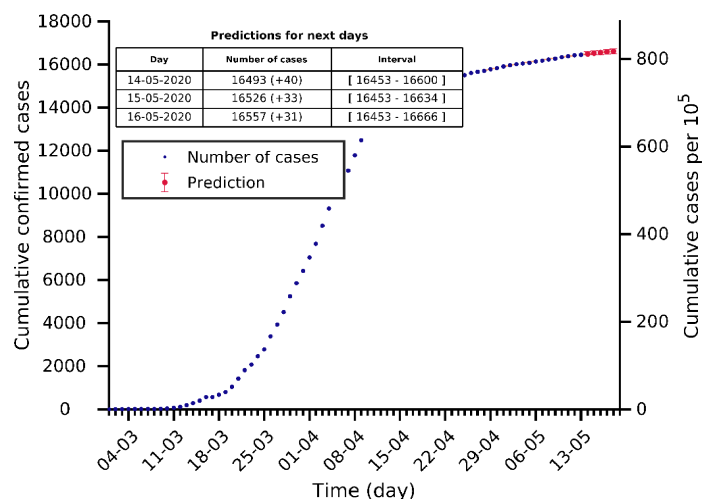
Catalunya 13-05-2020. Population: 7.7M. Current cumulated incidence: 685/10⁵



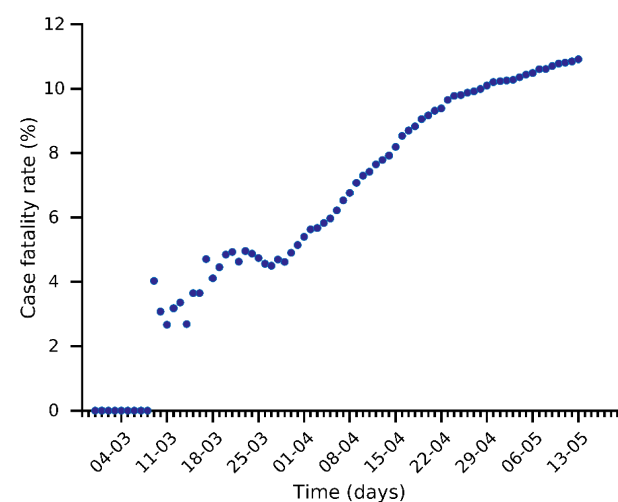
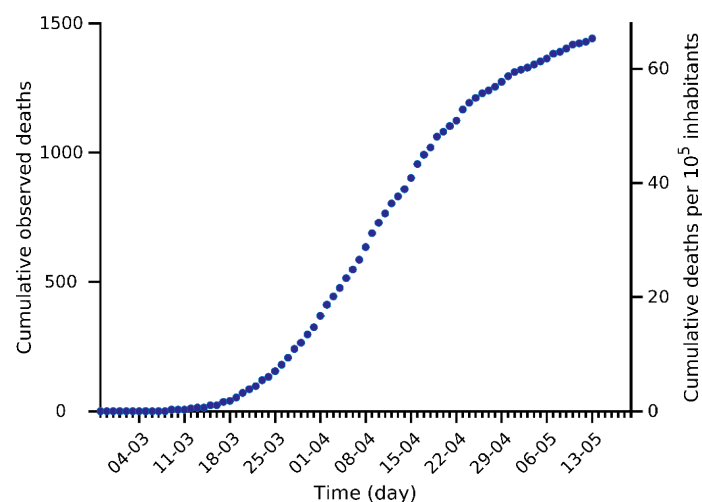
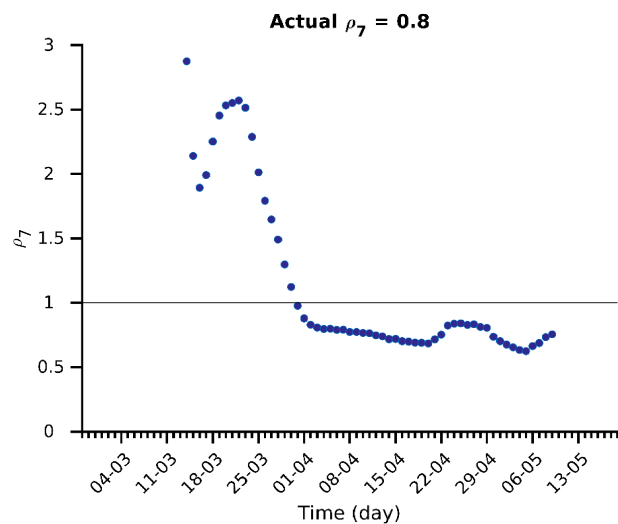
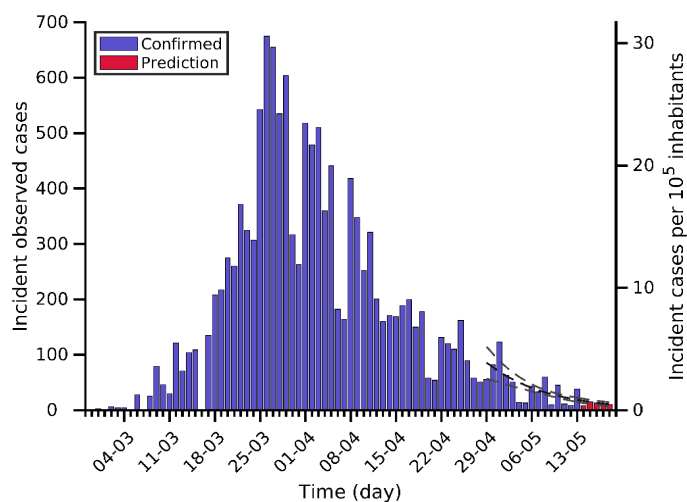
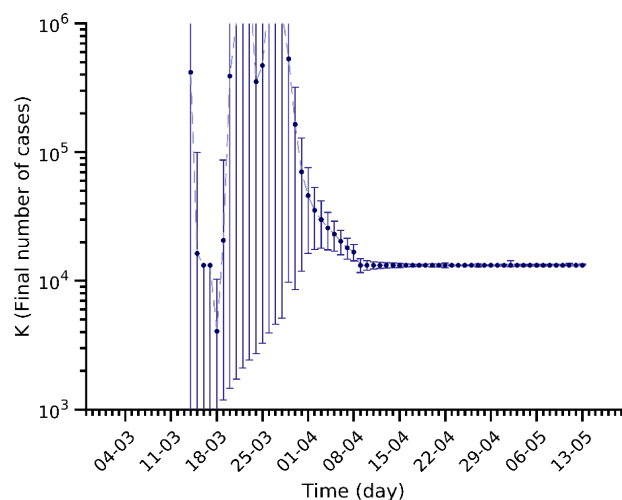
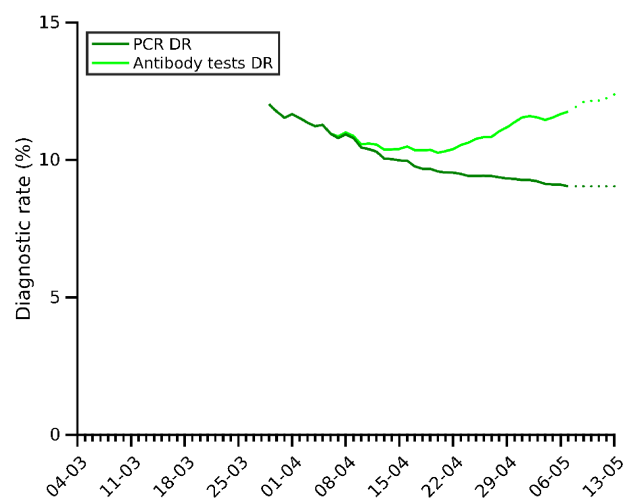
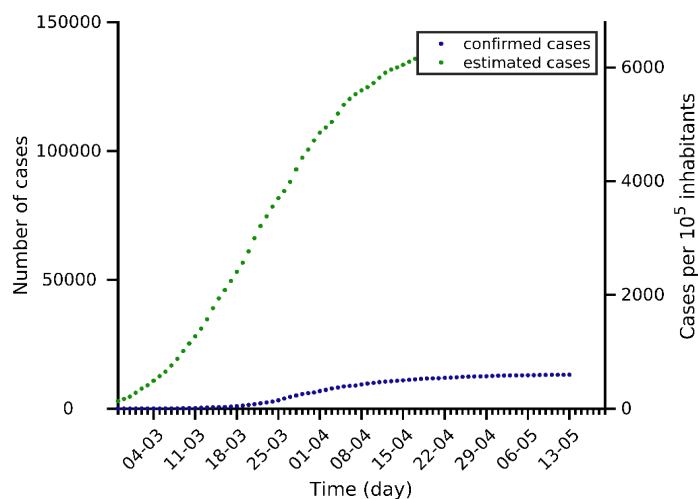
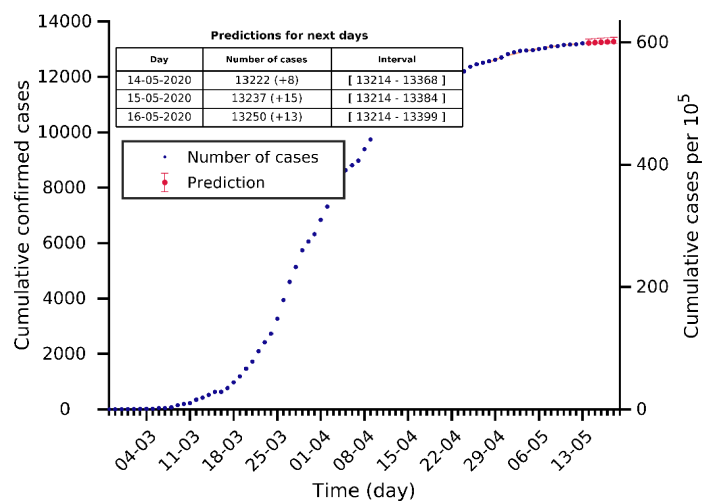
Castilla Leon 13-05-2020. Population: 2.4M. Current cumulated incidence: 755/10⁵



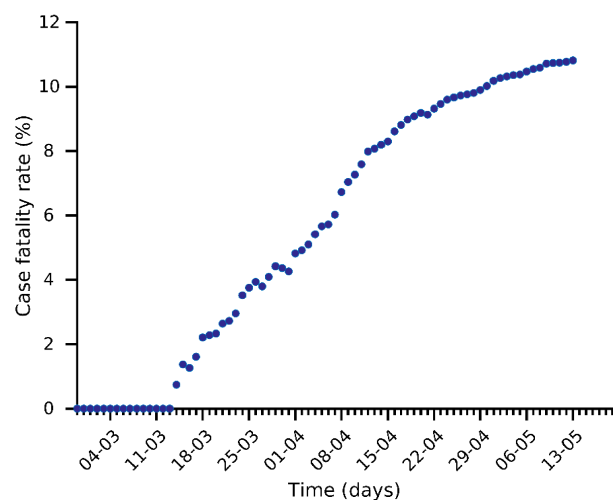
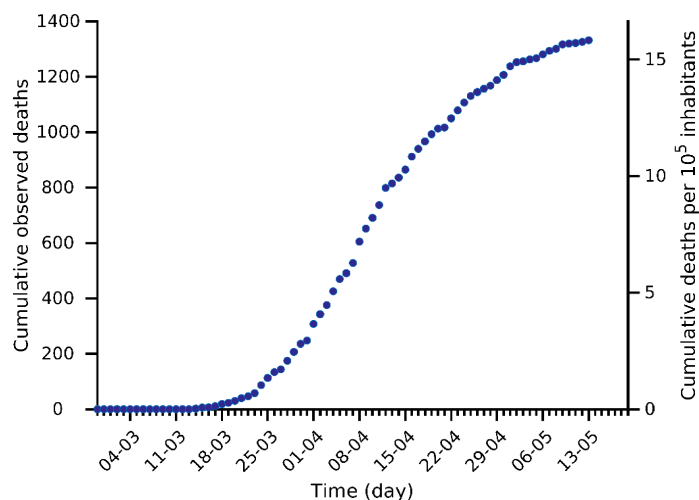
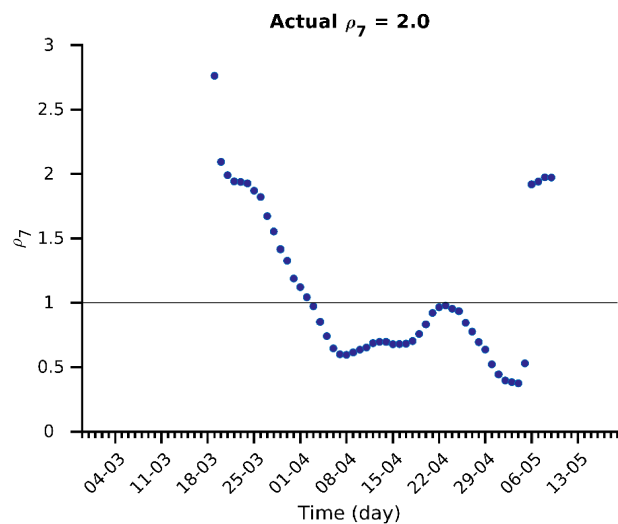
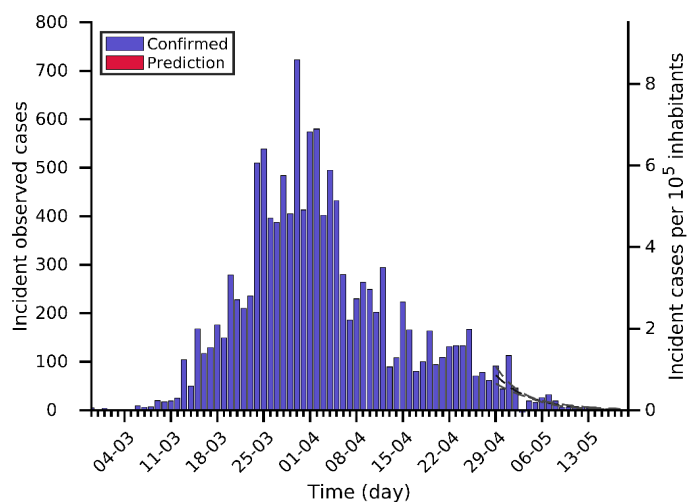
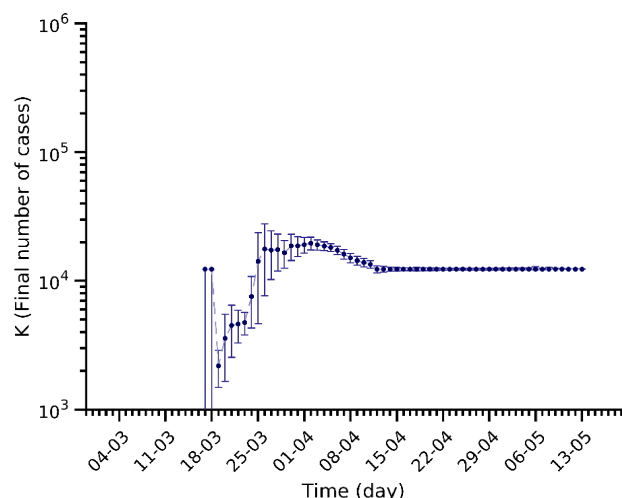
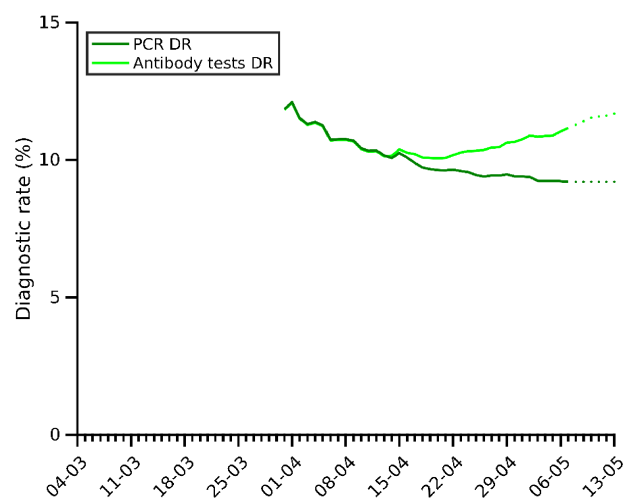
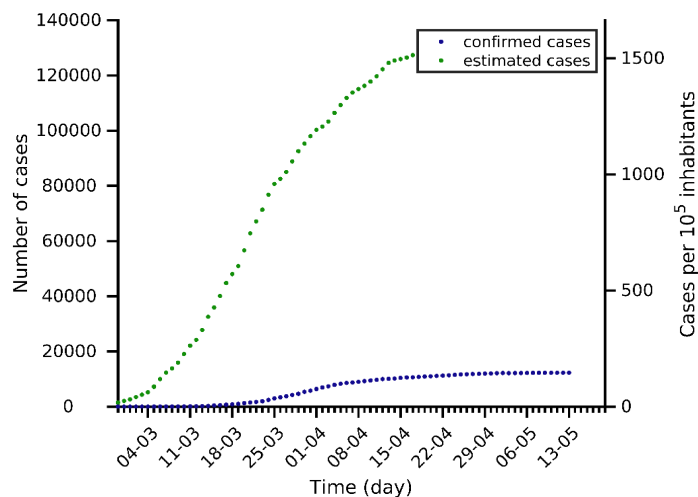
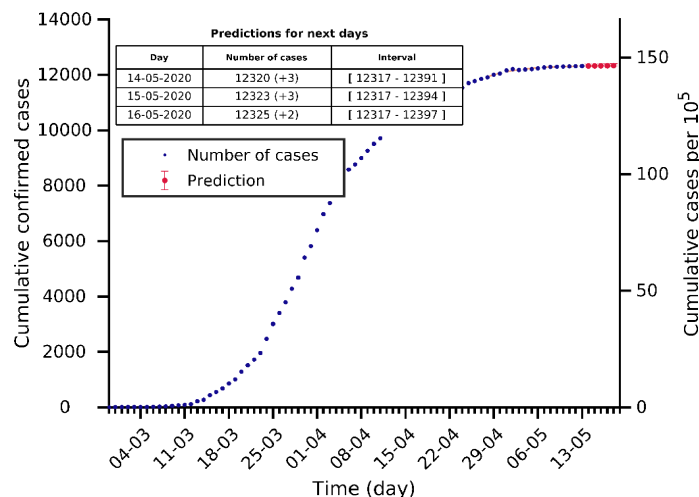
Castilla-La Mancha 13-05-2020. Population: 2.0M. Current cumulated incidence: 80



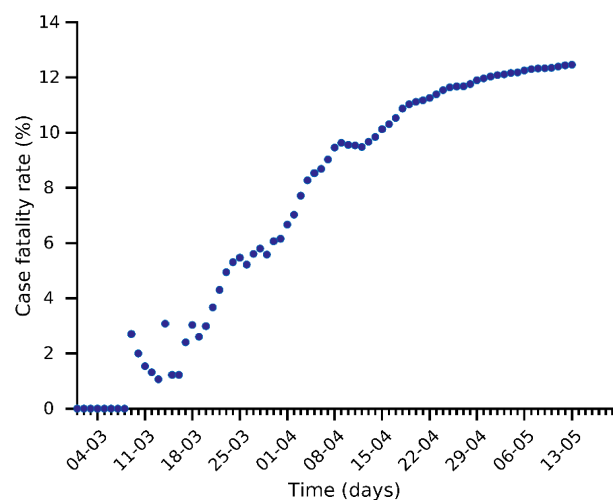
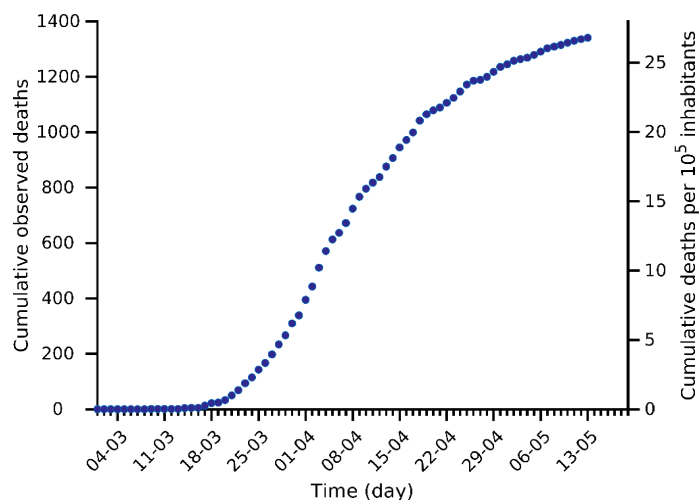
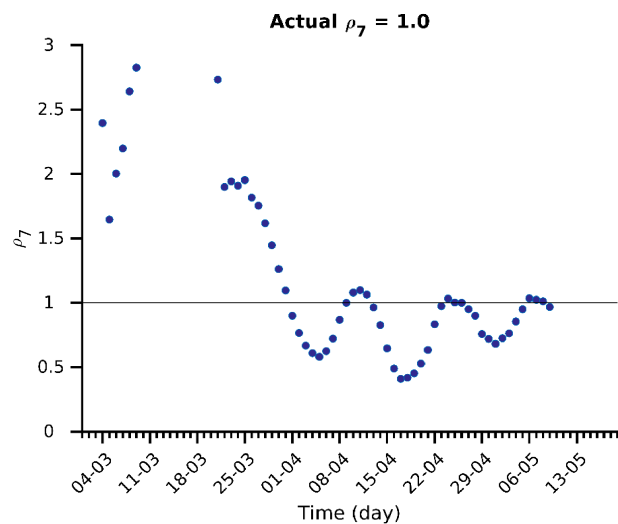
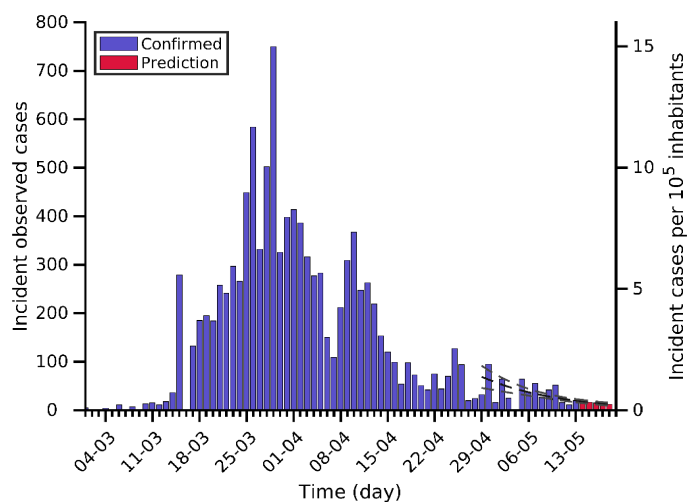
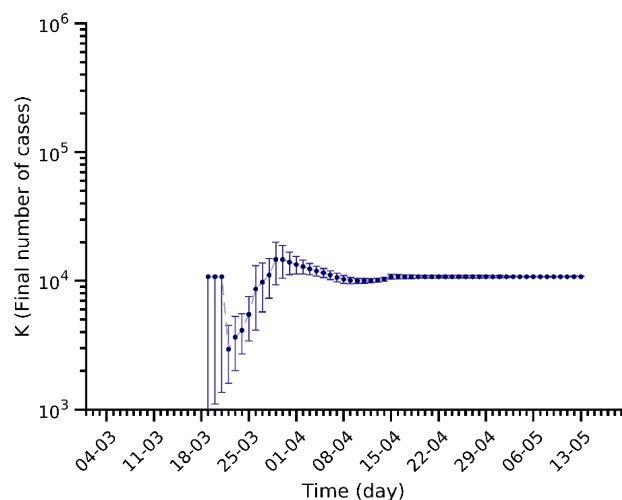
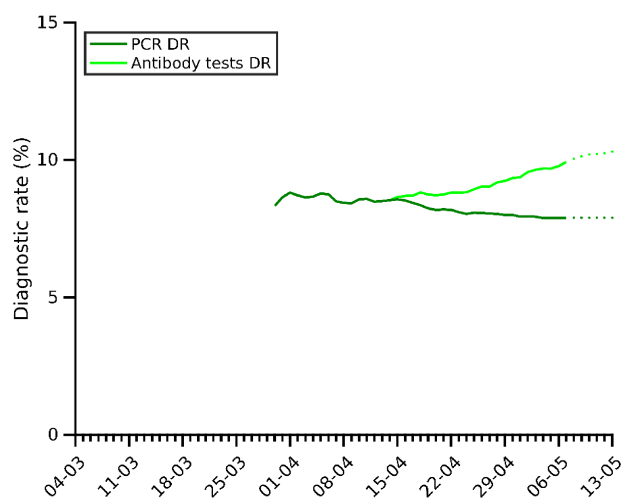
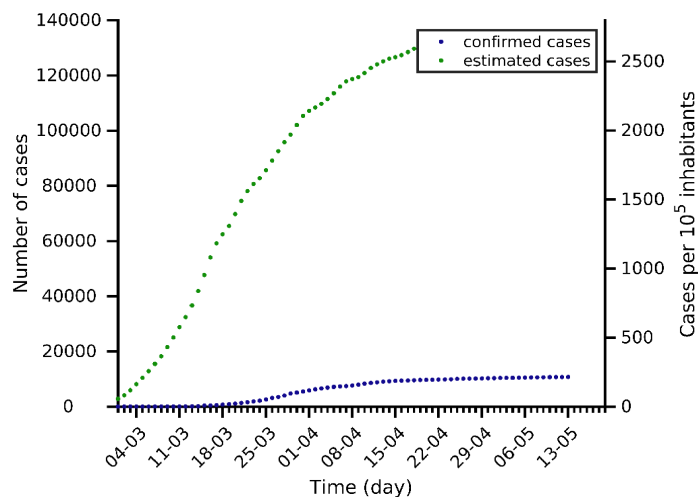
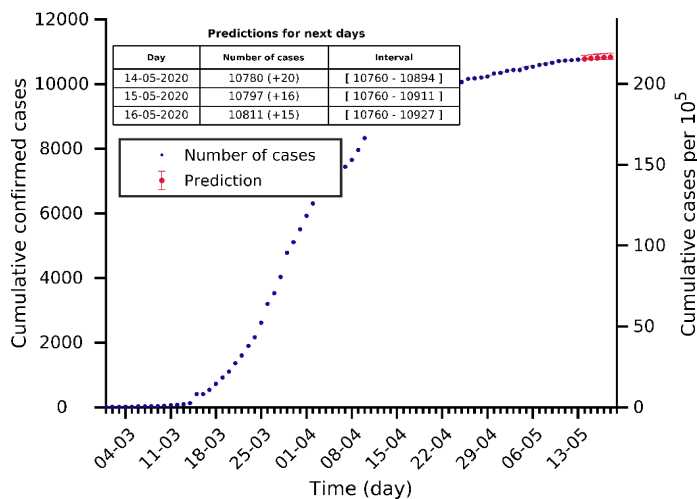
Euskadi 13-05-2020. Population: 2.2M. Current cumulated incidence: 599/10⁵



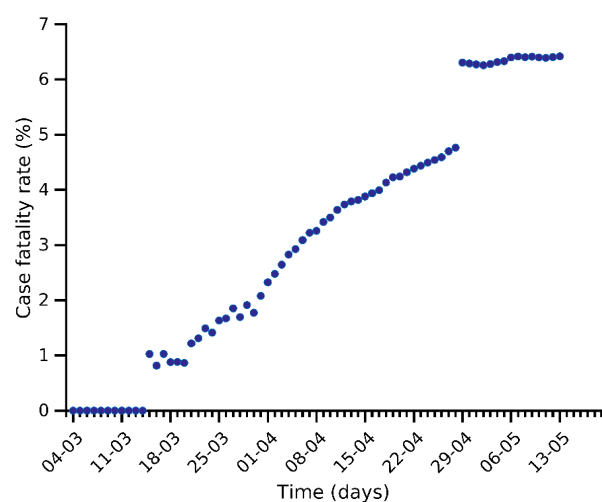
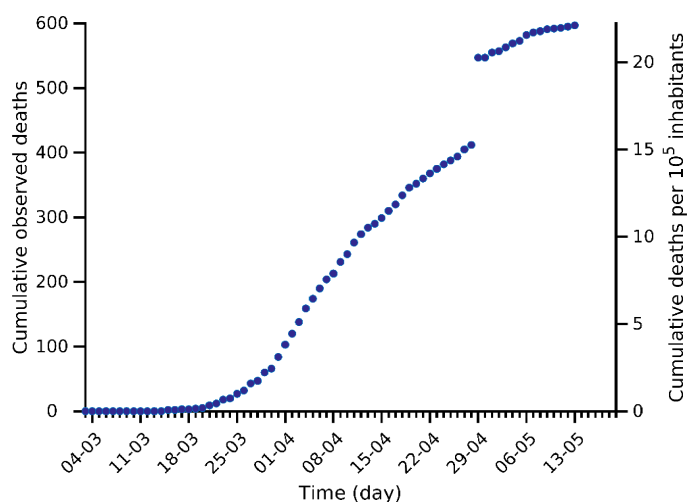
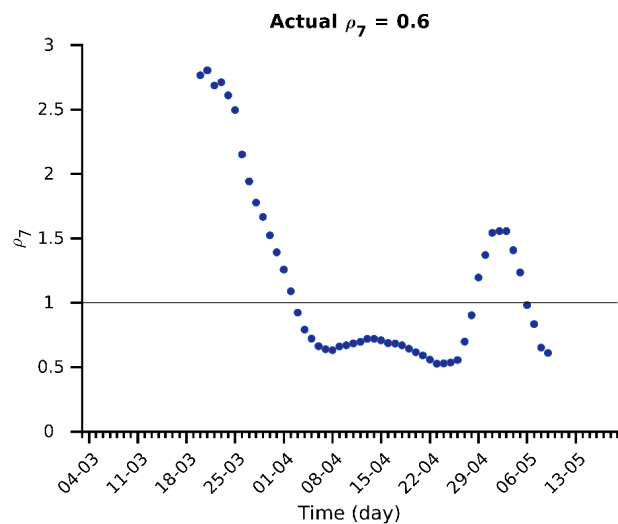
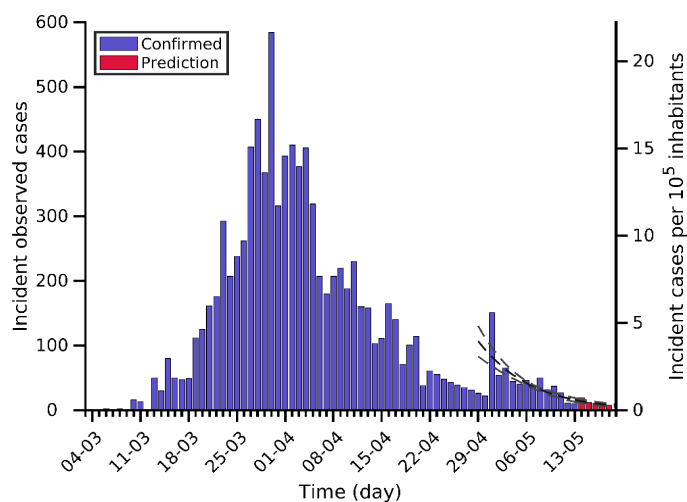
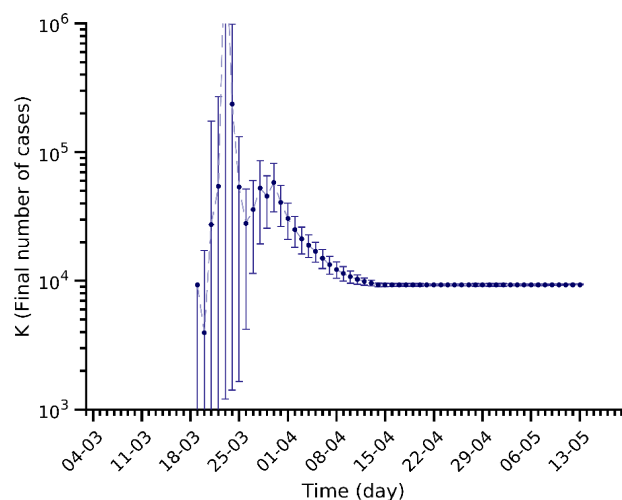
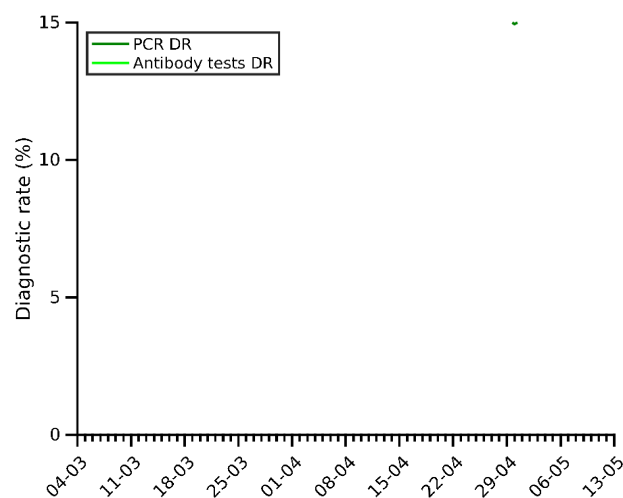
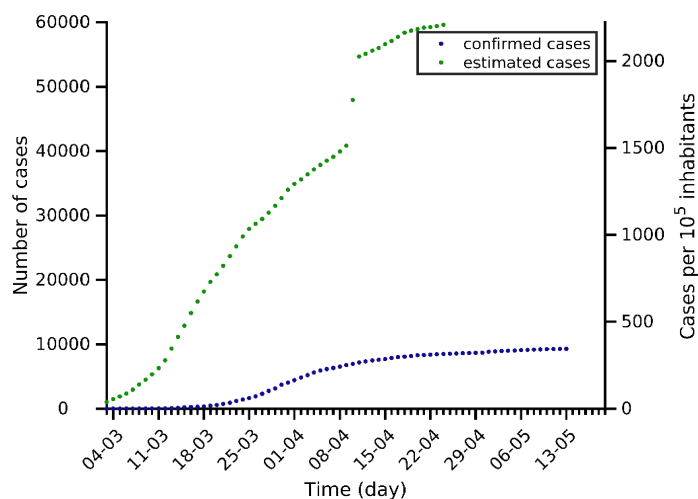
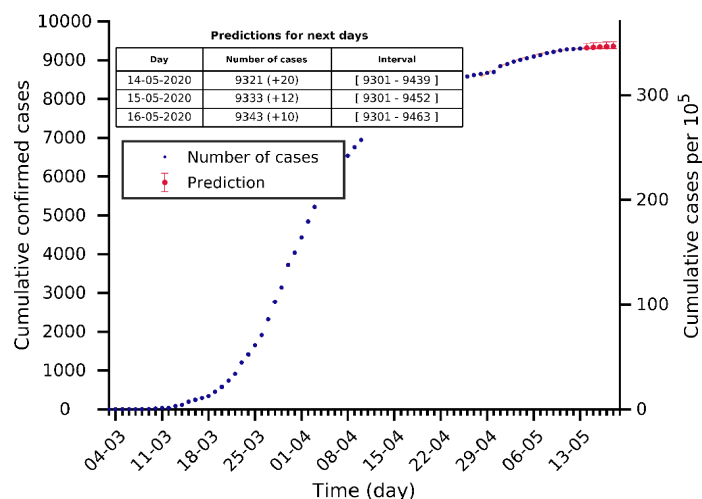
Andalucia 13-05-2020. Population: 8.4M. Current cumulated incidence: 146/10⁵



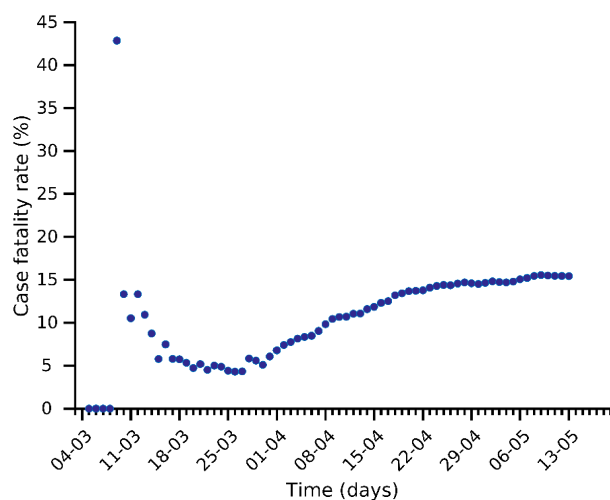
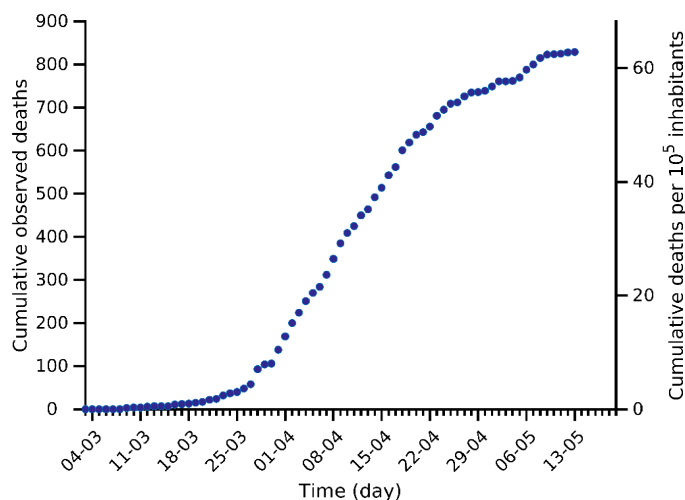
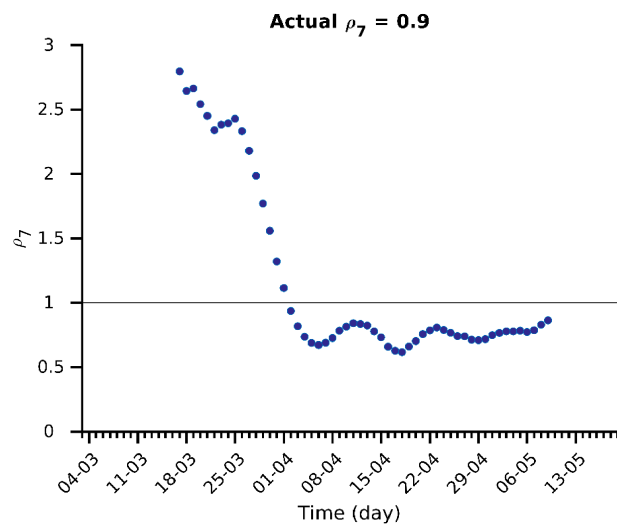
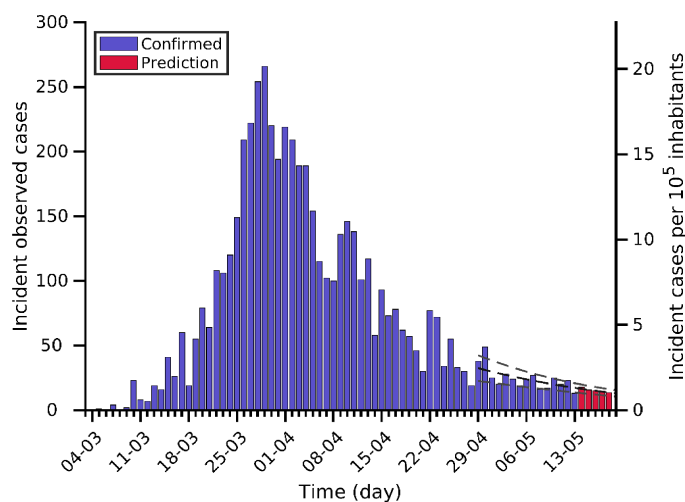
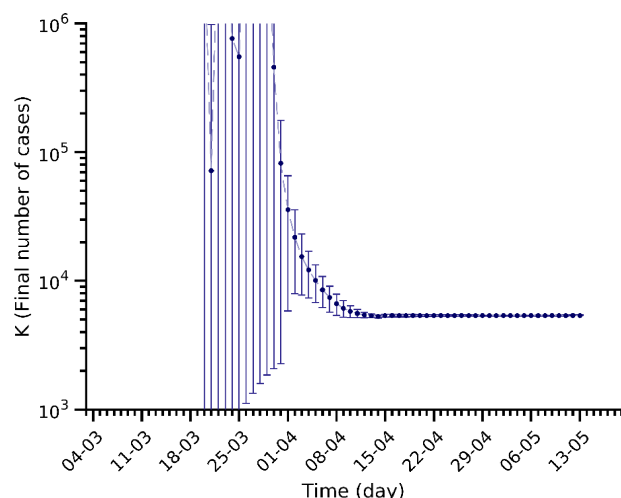
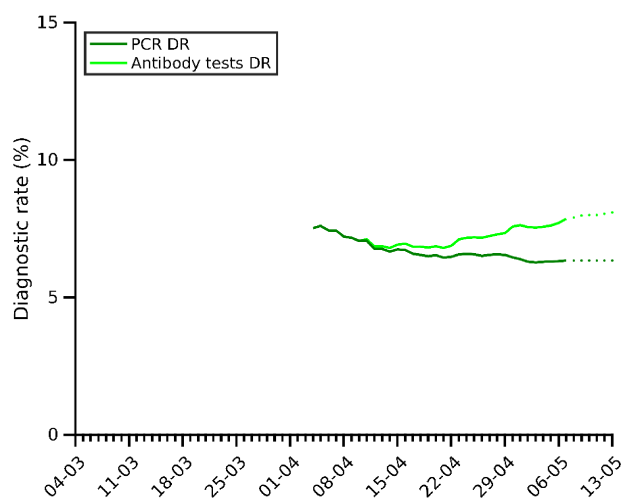
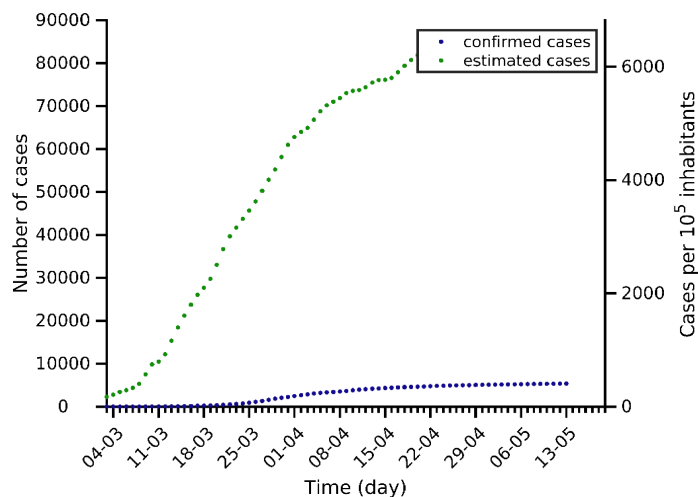
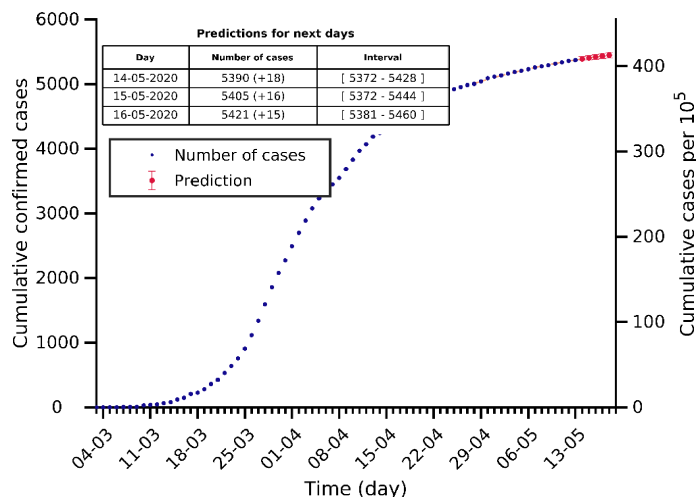
C Valenciana 13-05-2020. Population: 5.0M. Current cumulated incidence: 215/10⁵



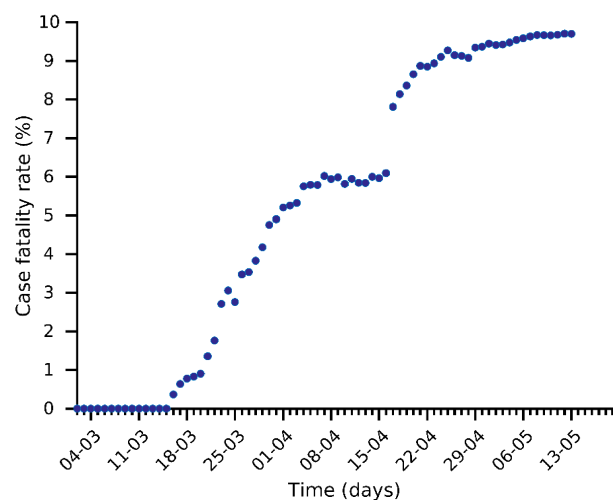
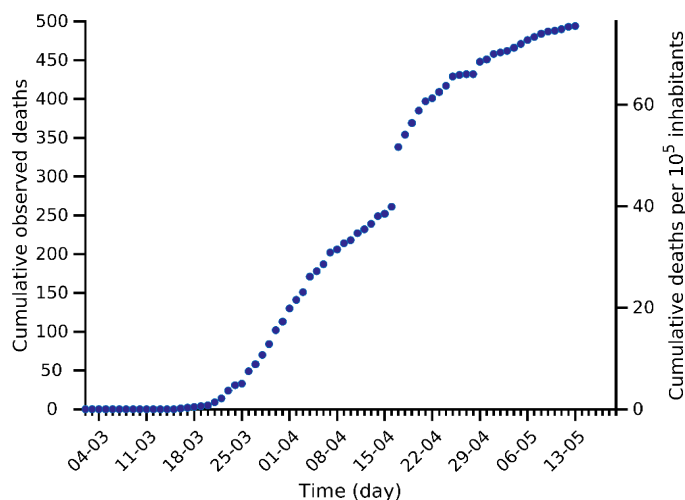
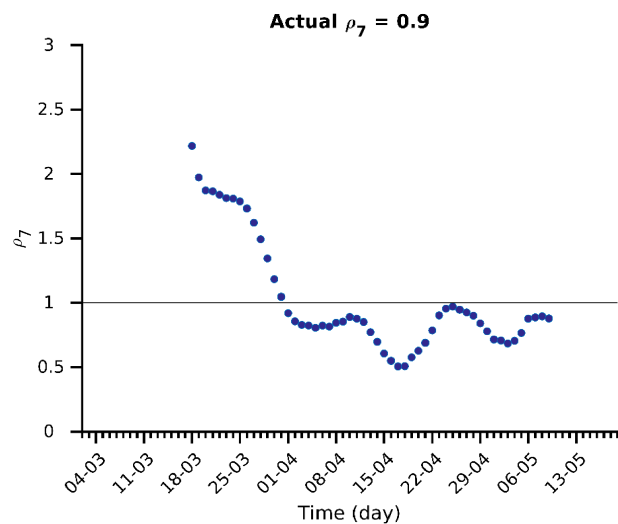
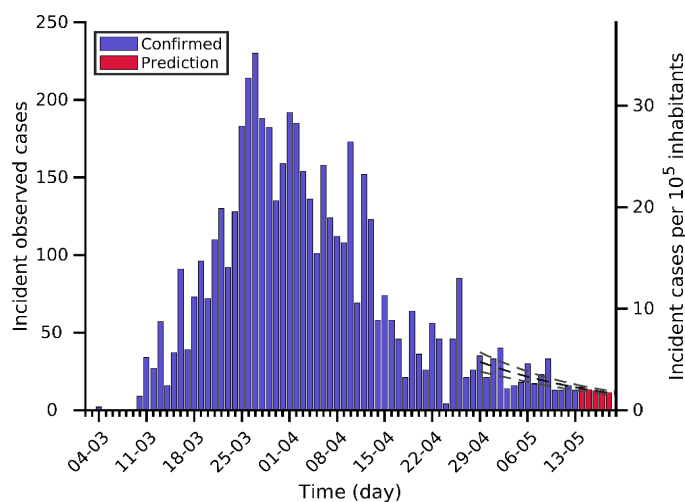
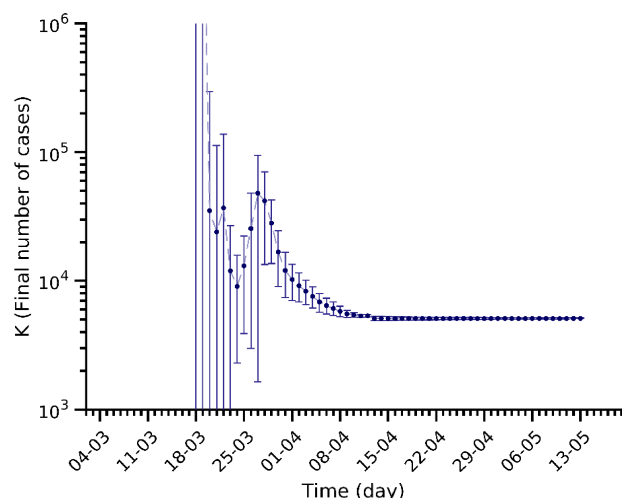
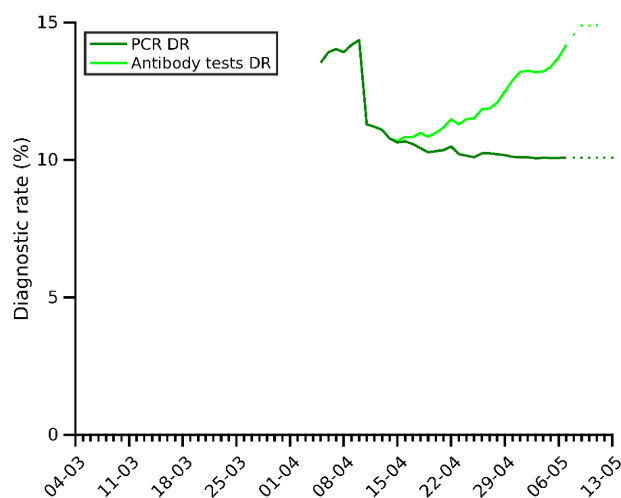
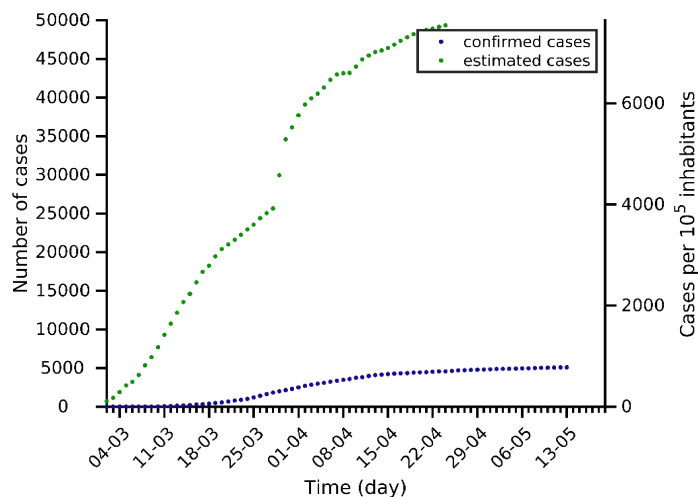
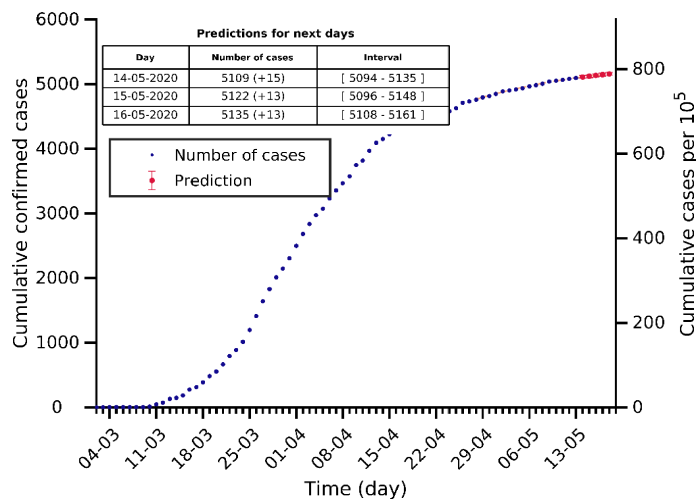
Galicia 13-05-2020. Population: 2.7M. Current cumulated incidence: 345/10⁵



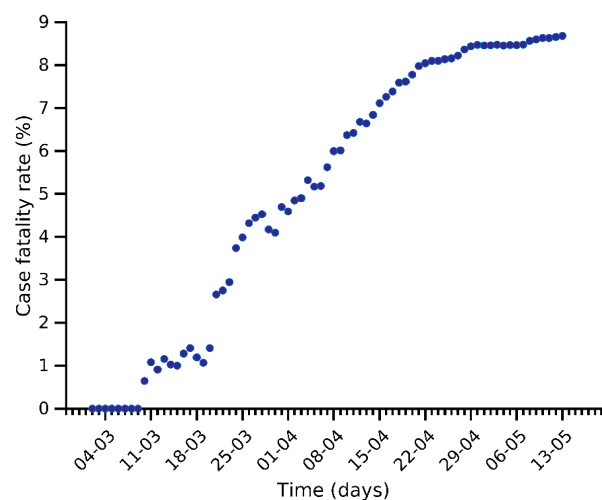
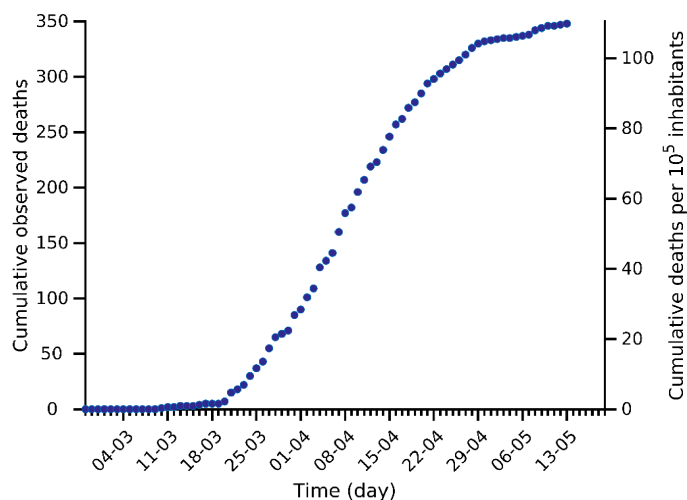
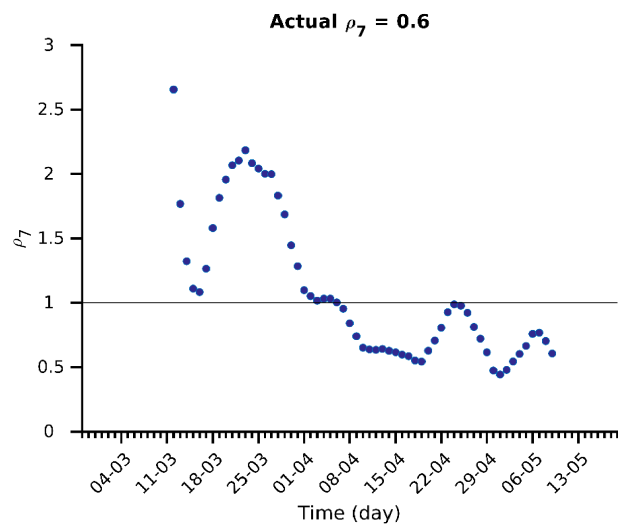
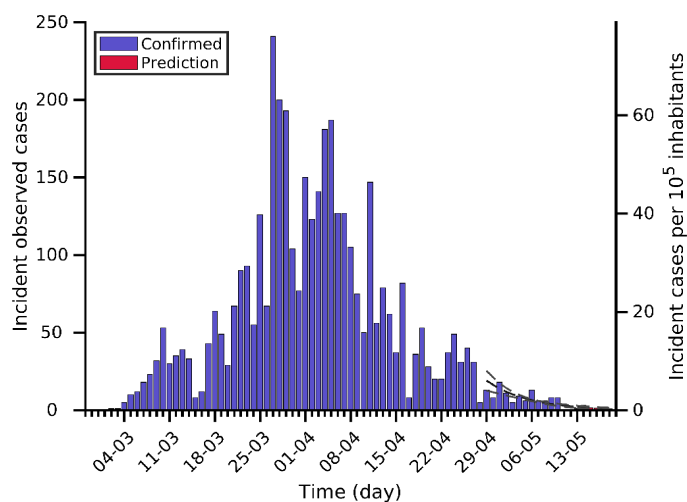
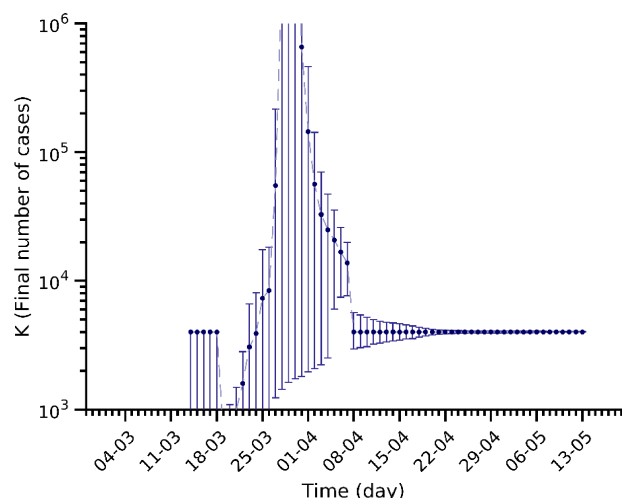
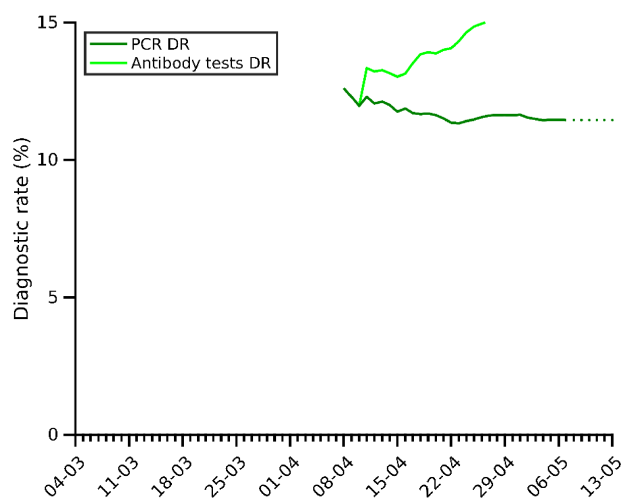
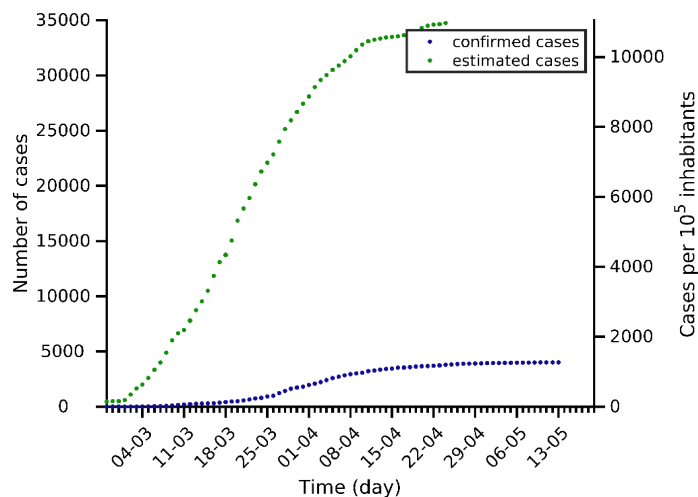
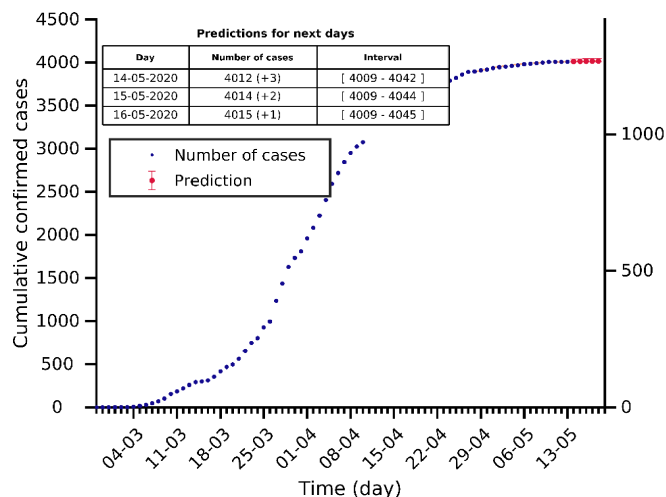
Aragon 13-05-2020. Population: 1.3M. Current cumulated incidence: 407/10⁵



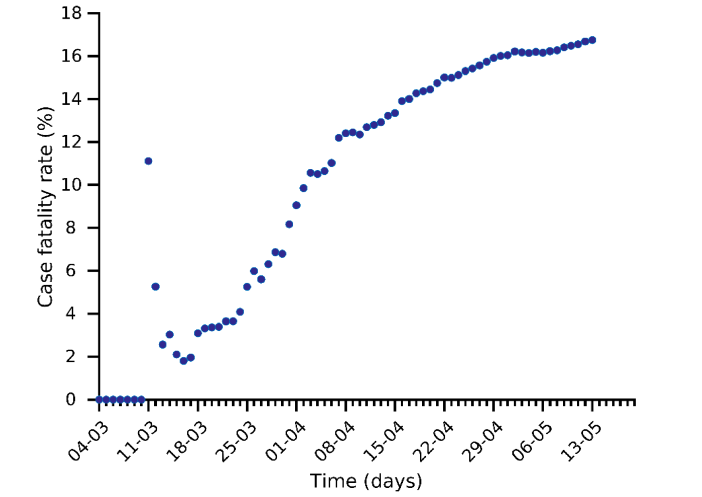
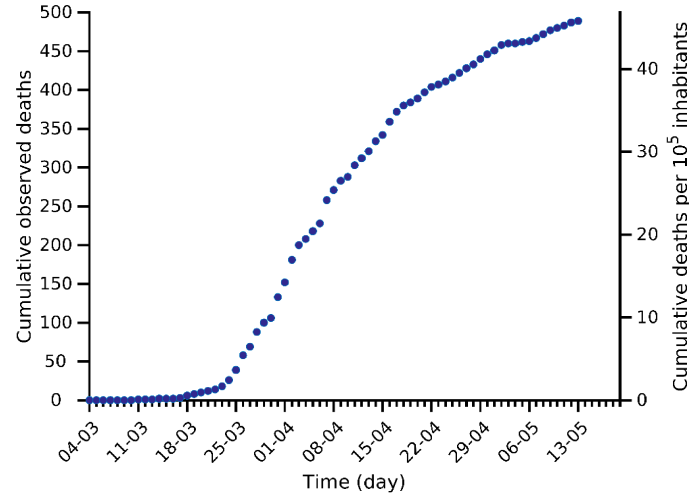
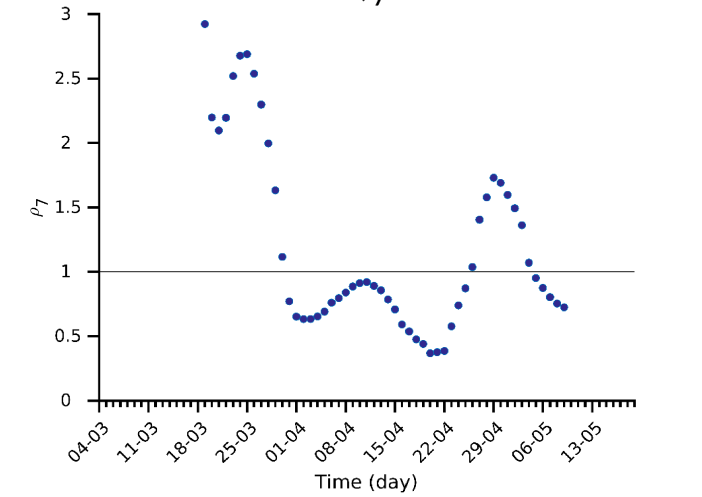
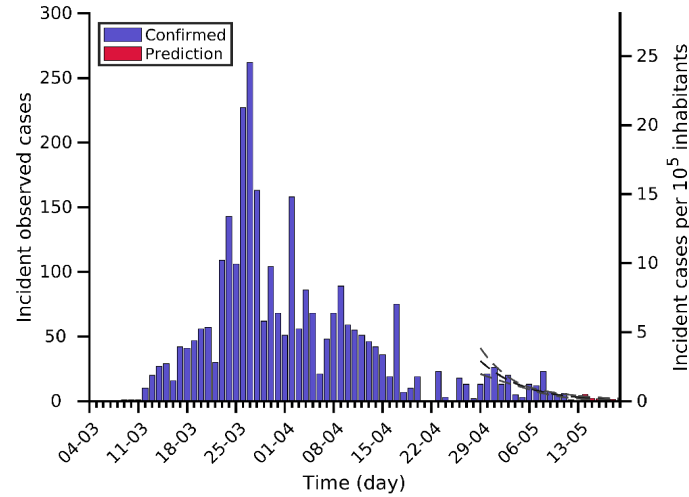
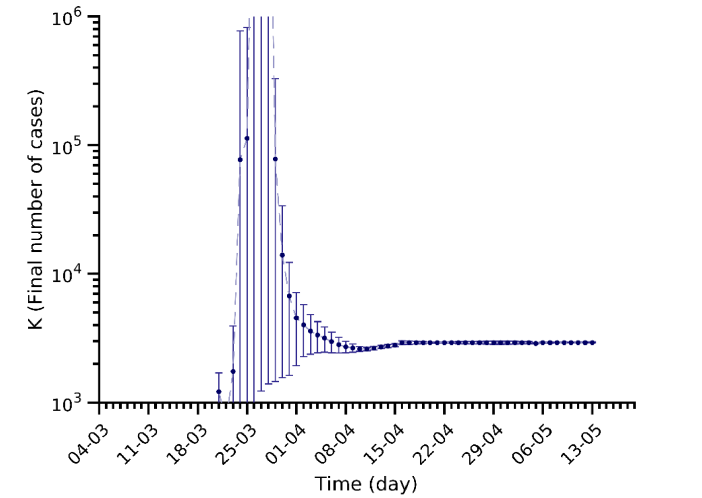
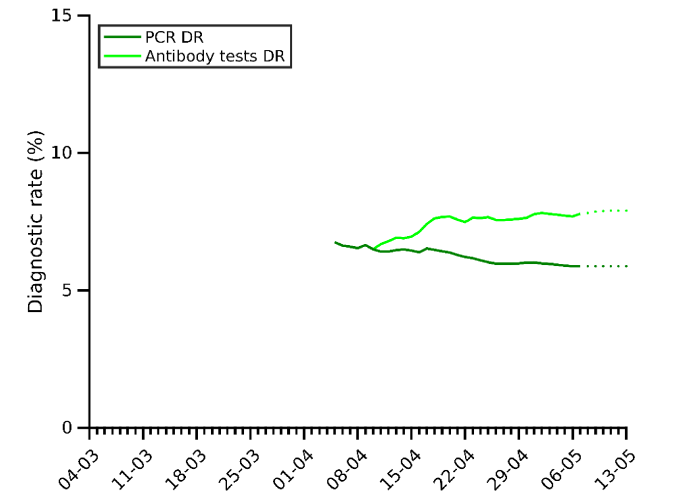
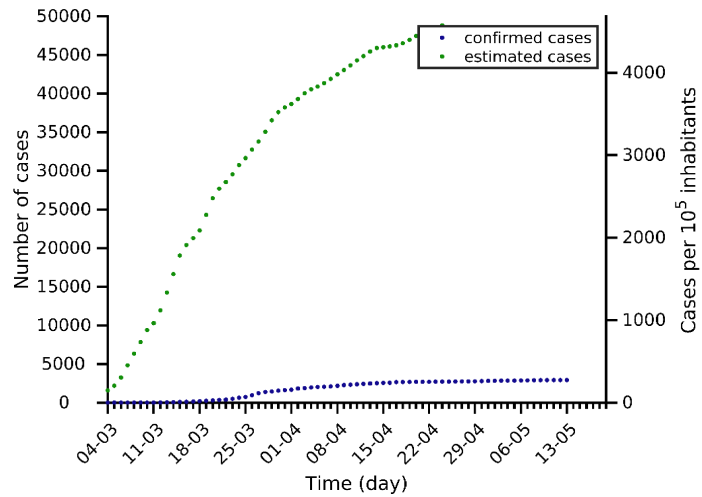
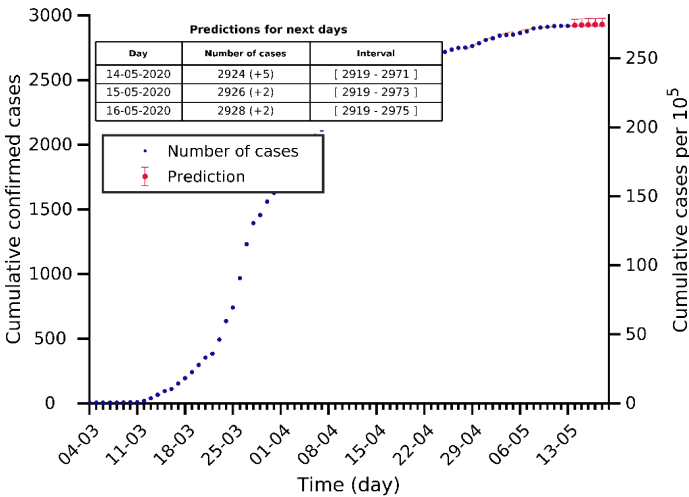
Navarra 13-05-2020. Population: 0.7M. Current cumulated incidence: 779/10⁵



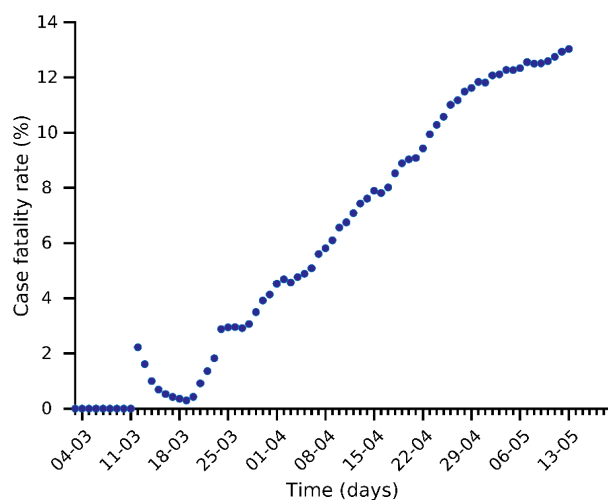
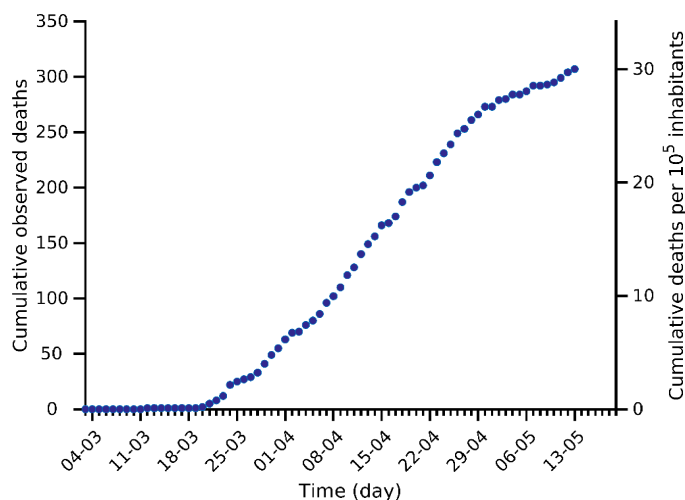
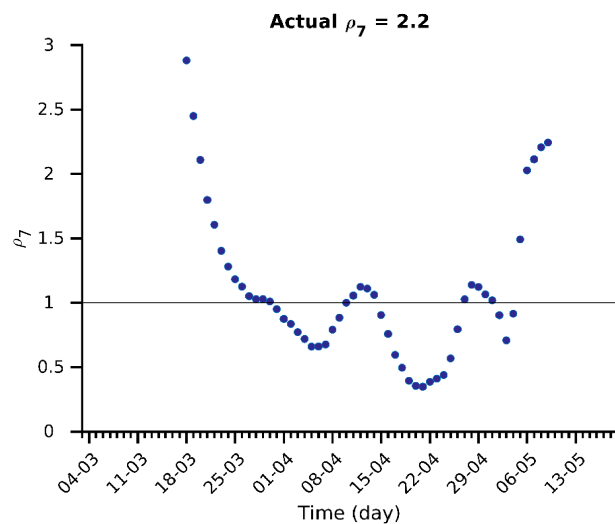
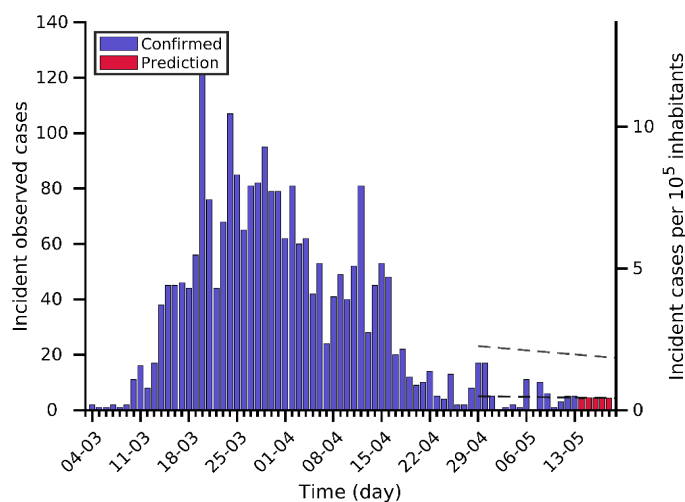
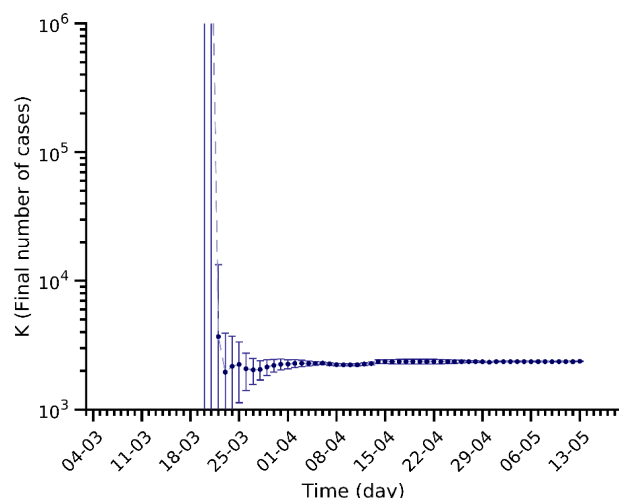
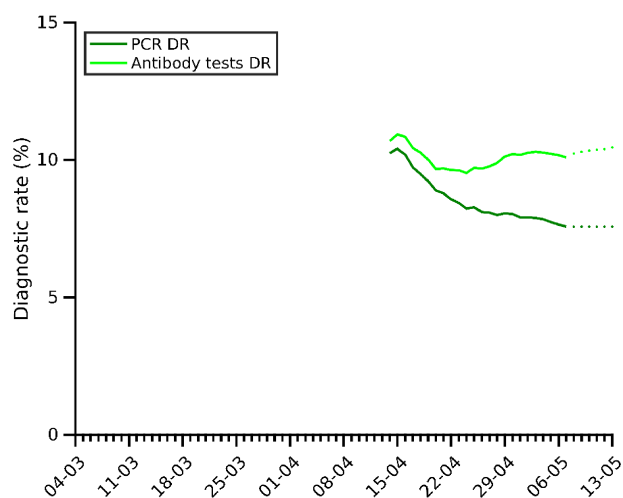
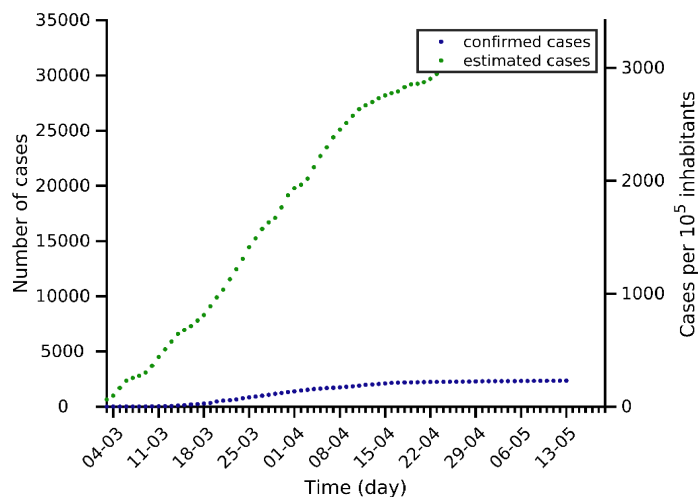
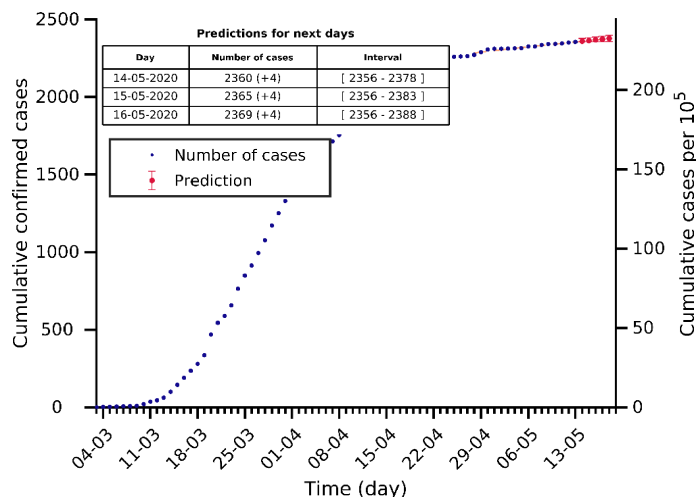
La Rioja 13-05-2020. Population: 0.3M. Current cumulated incidence: 1265/10⁵



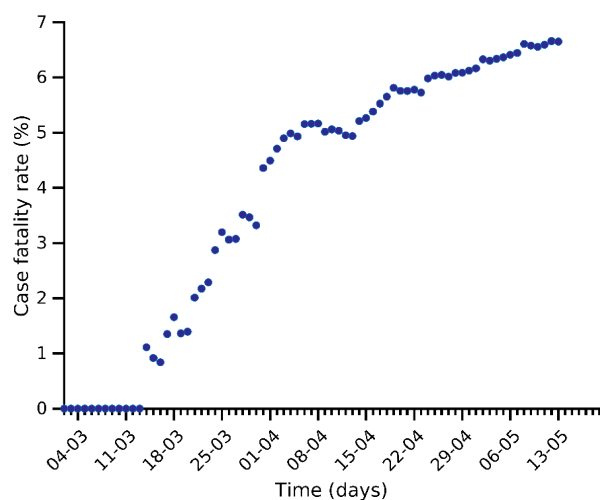
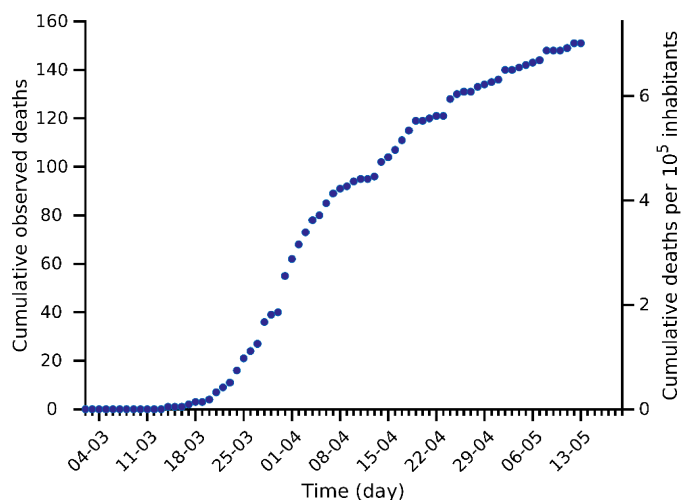
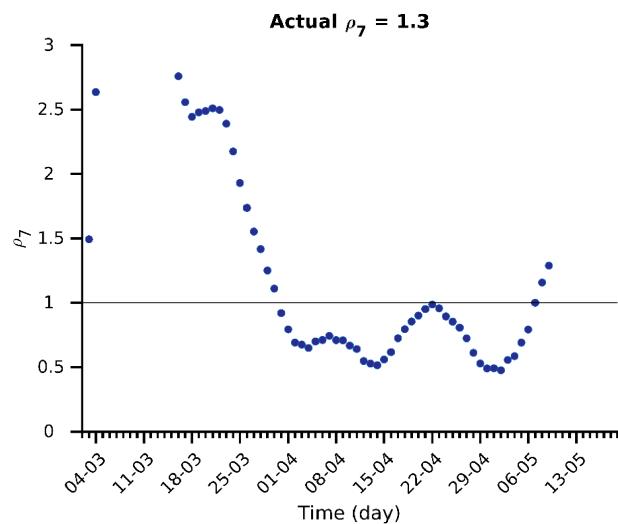
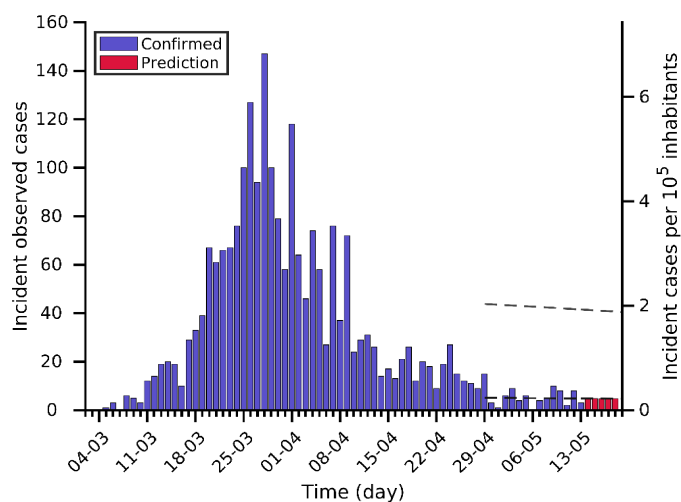
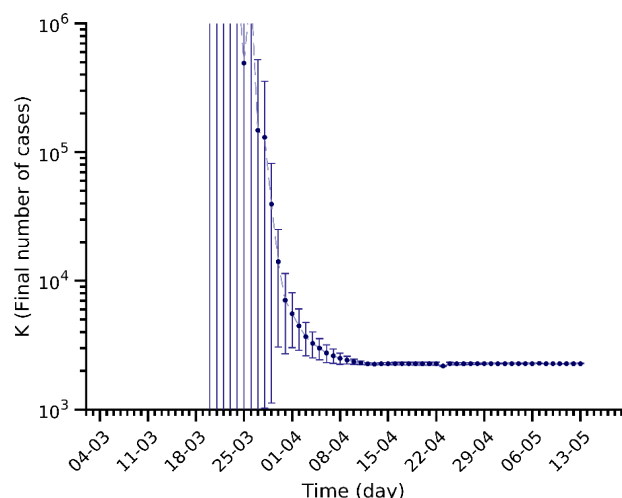
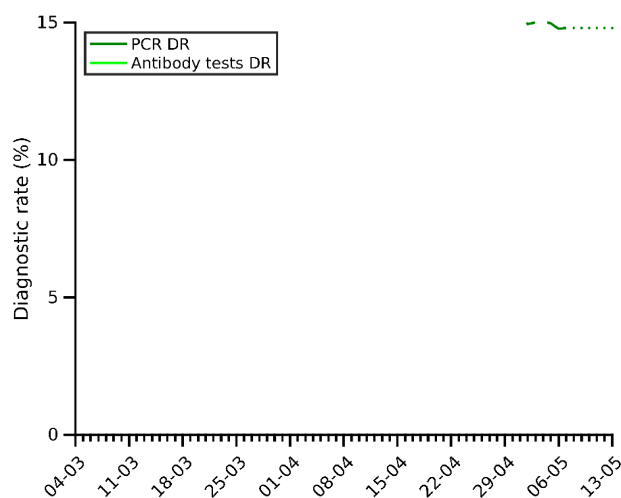
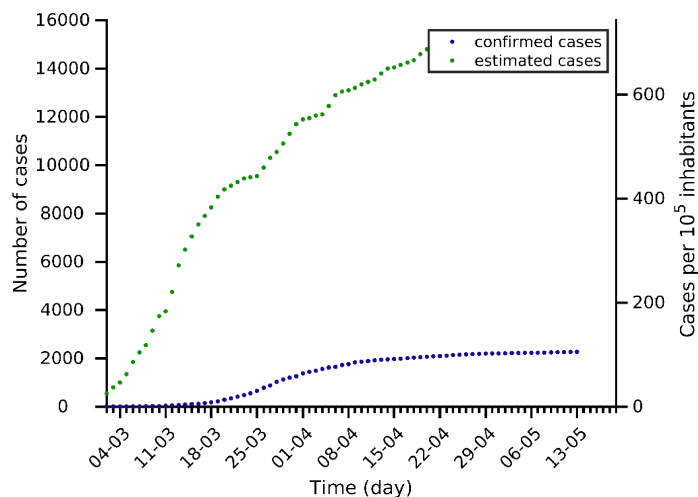
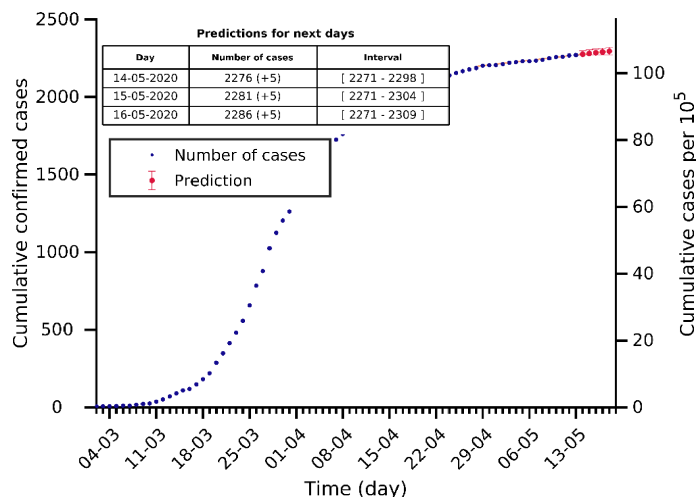
Extremadura 13-05-2020. Population: 1.1M. Current cumulated incidence: 273/10⁵



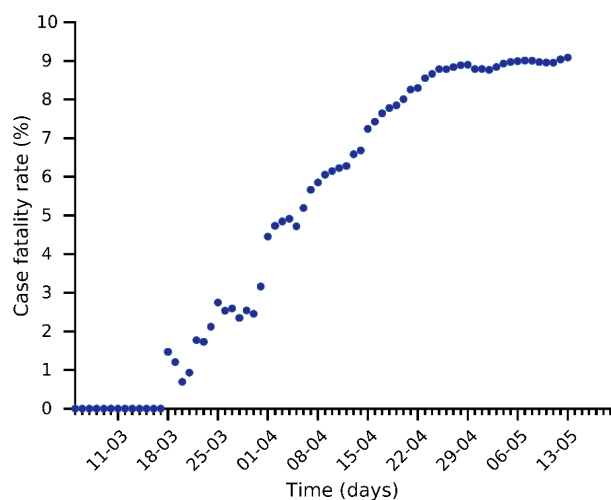
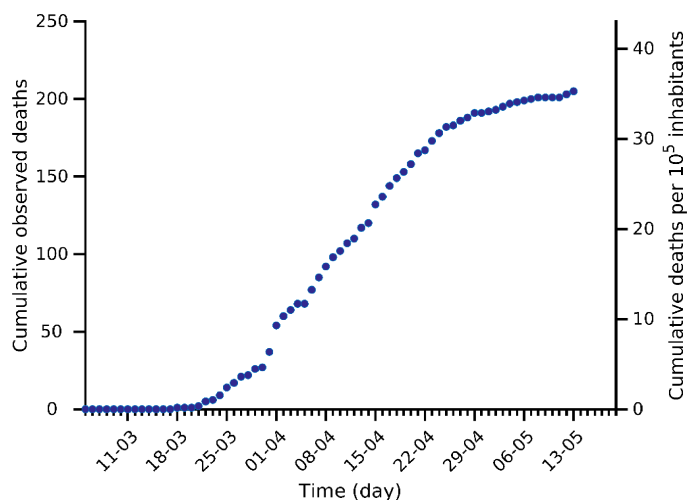
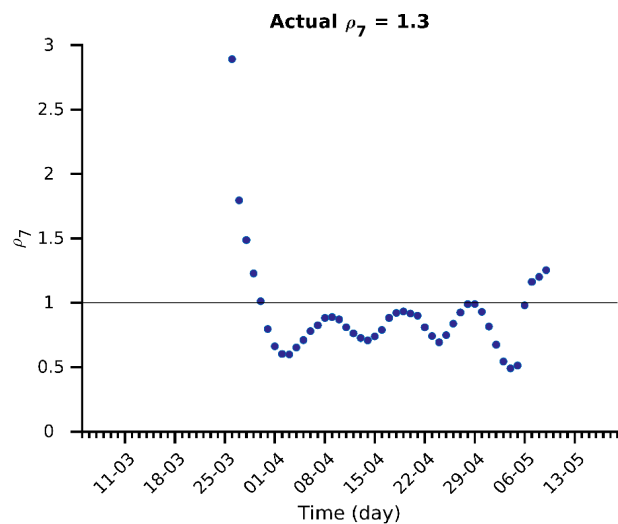
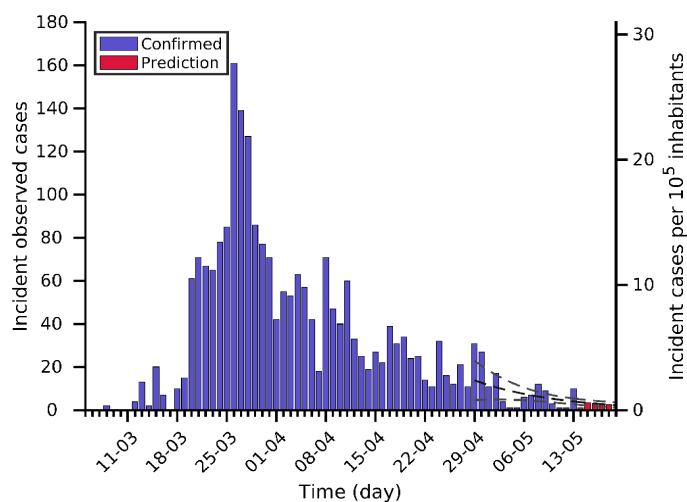
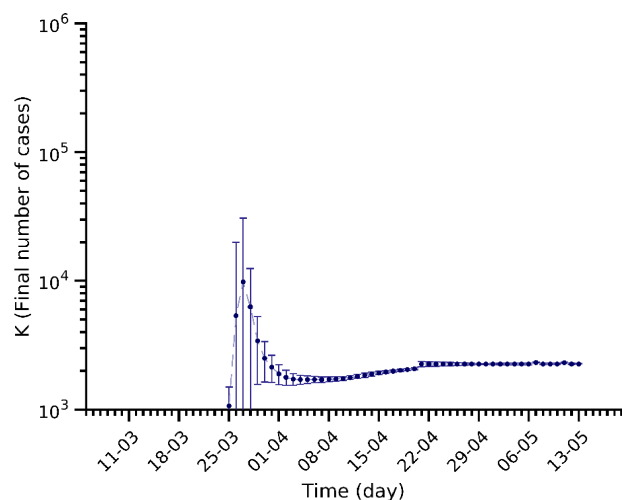
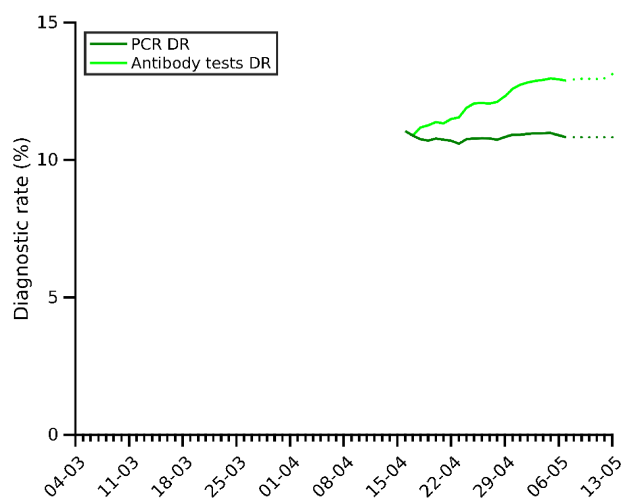
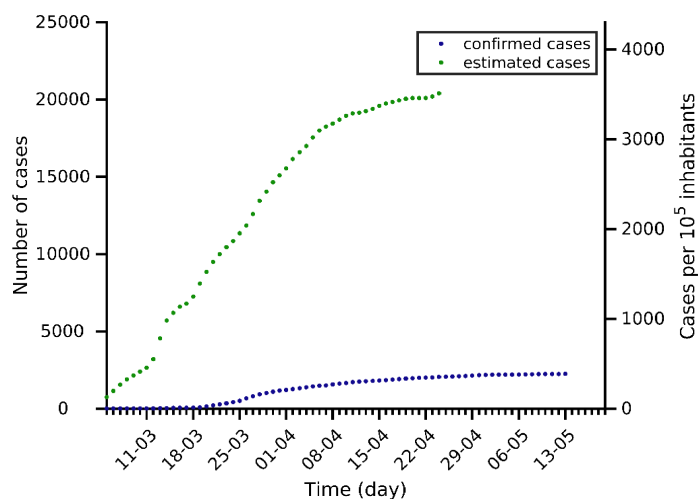
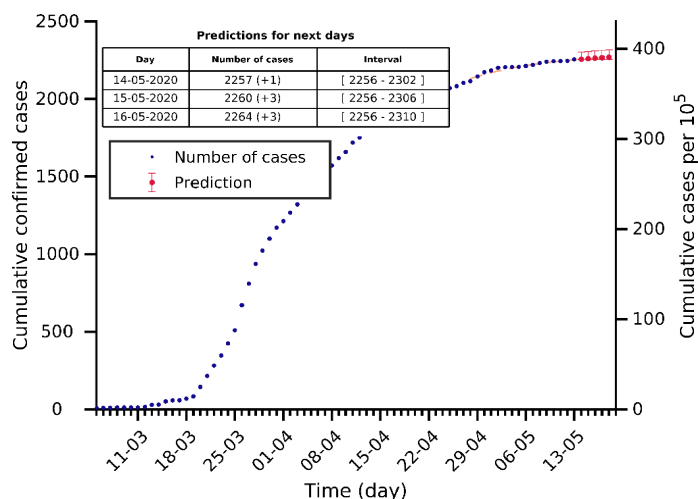
Asturias 13-05-2020. Population: 1.0M. Current cumulated incidence: 230/10⁵



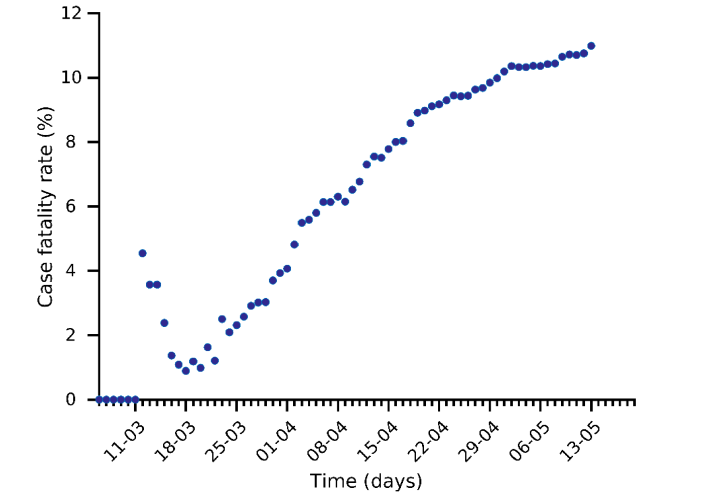
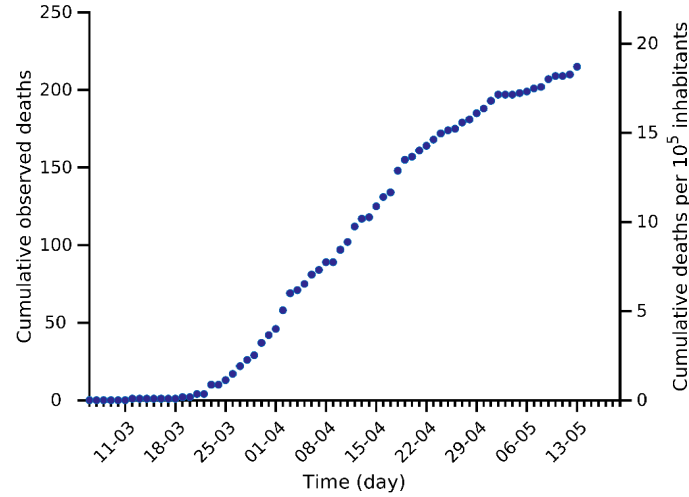
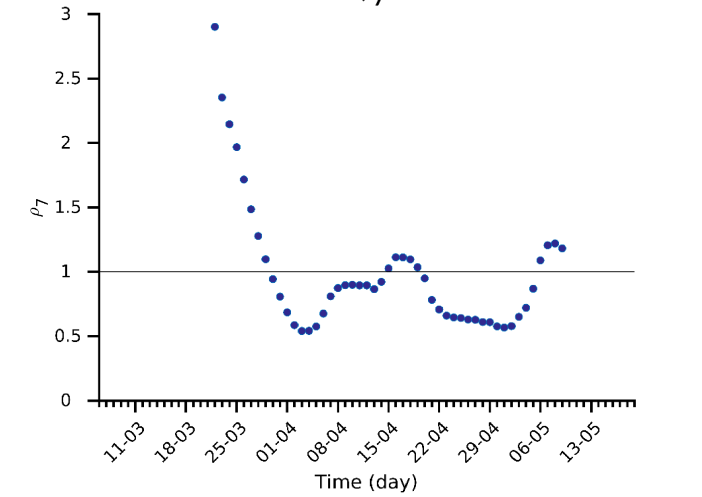
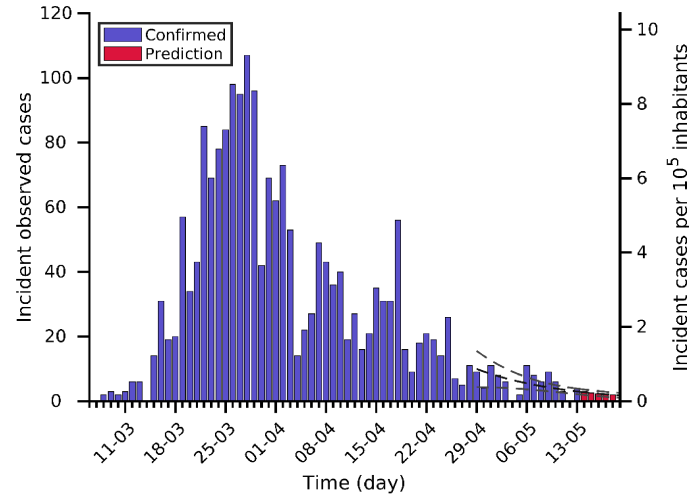
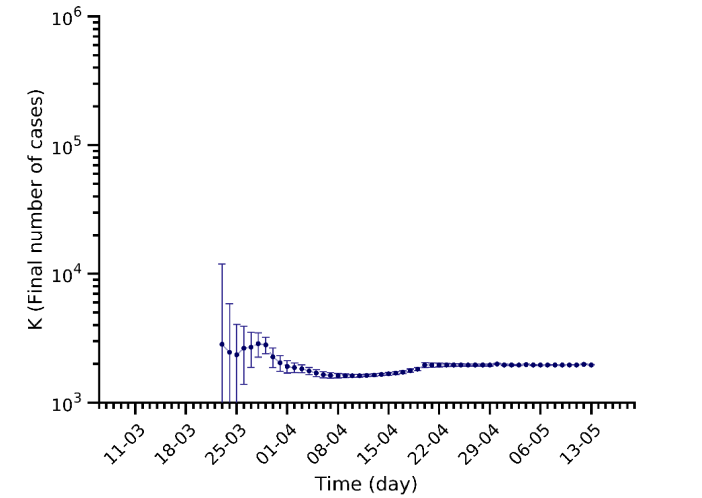
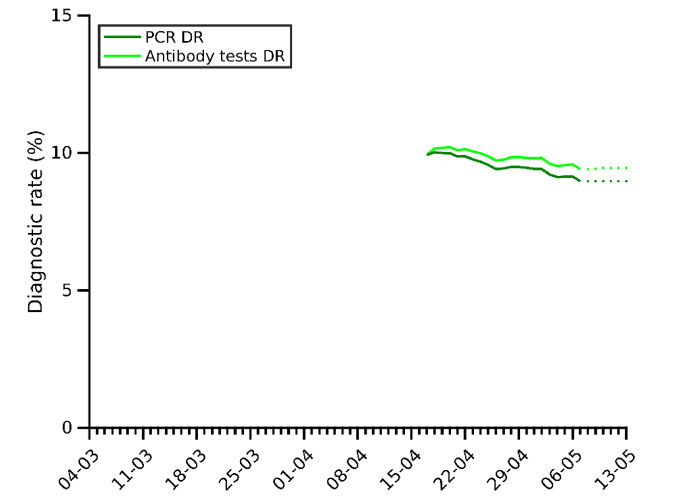
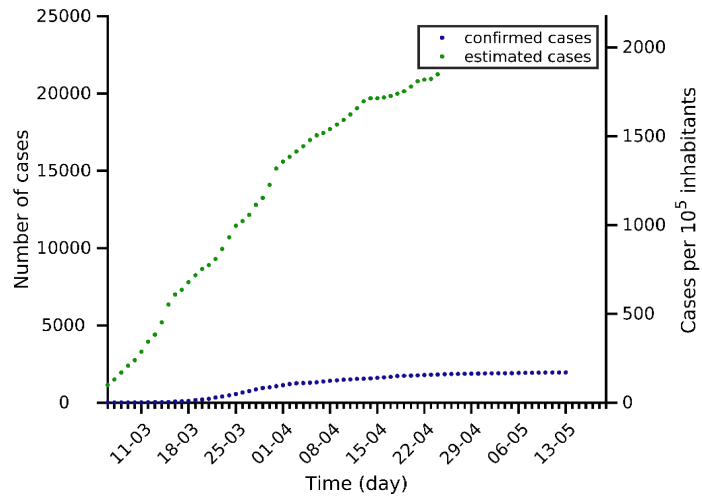
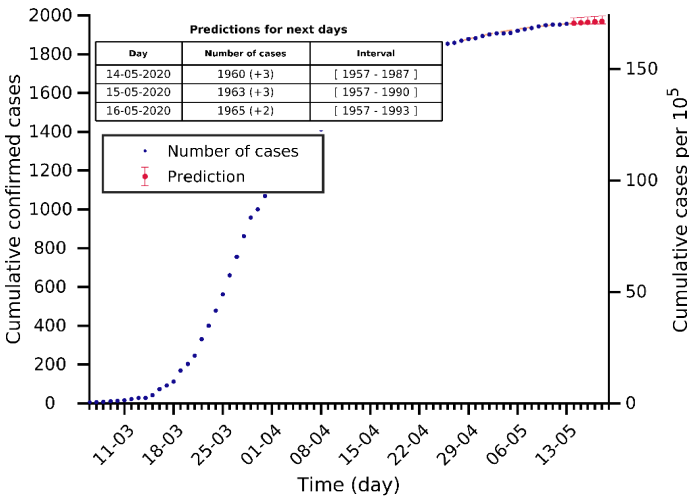
Canarias 13-05-2020. Population: 2.2M. Current cumulated incidence: 105/10⁵



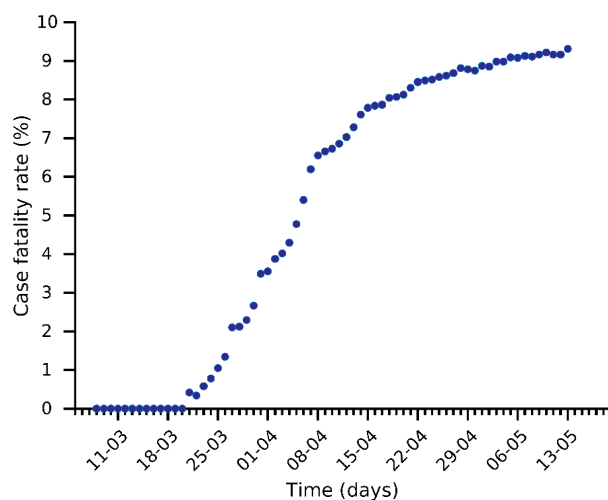
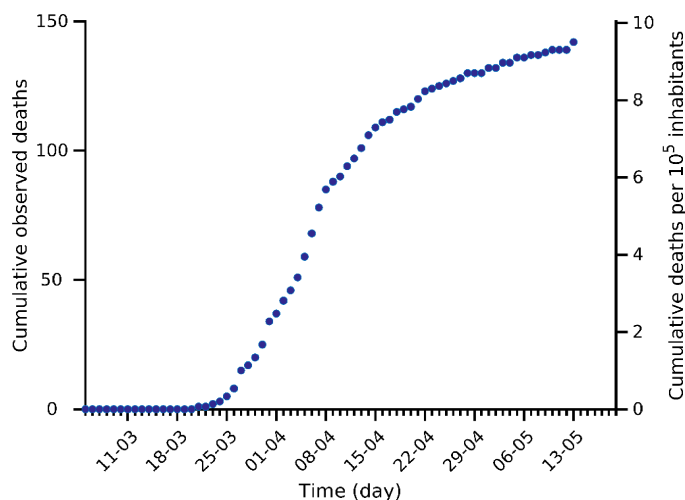
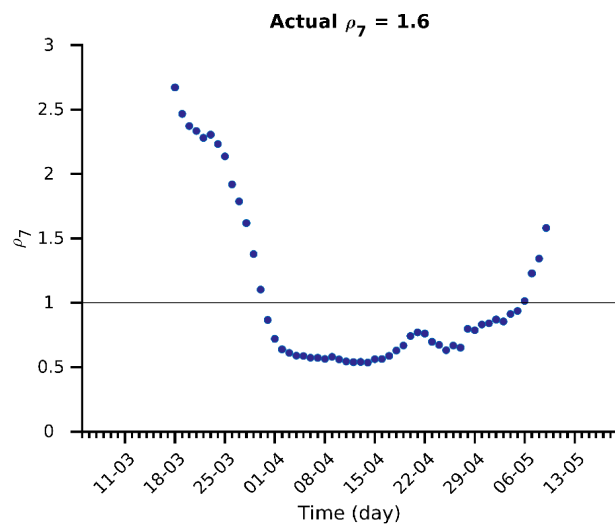
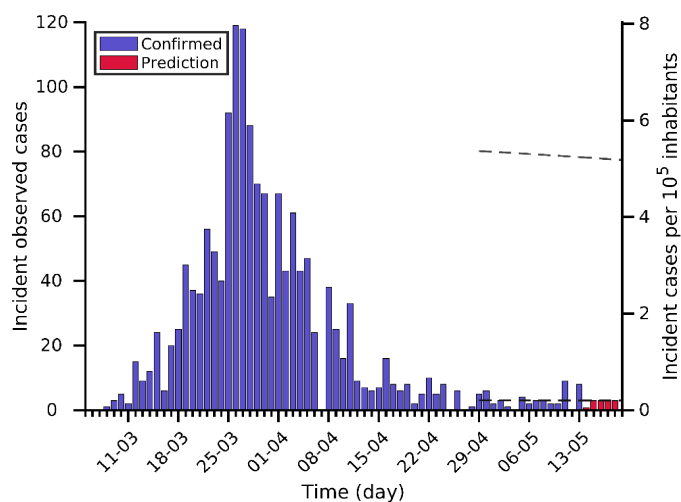
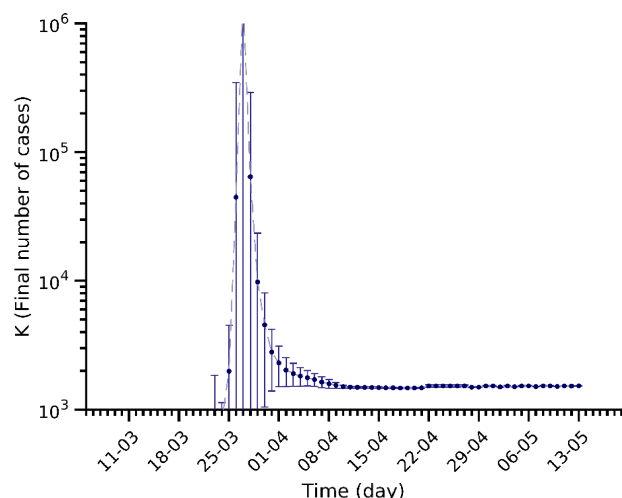
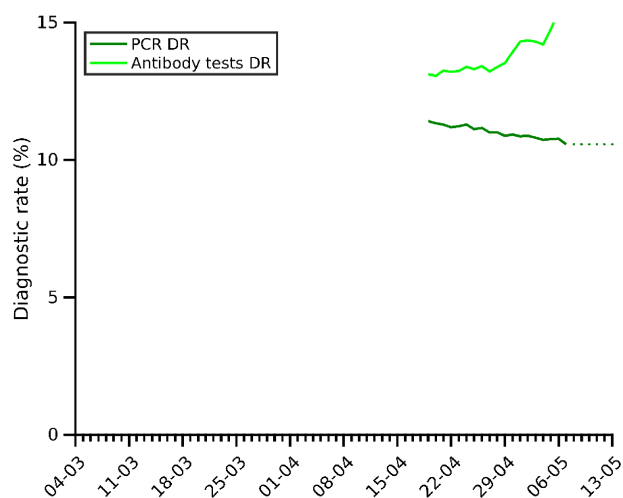
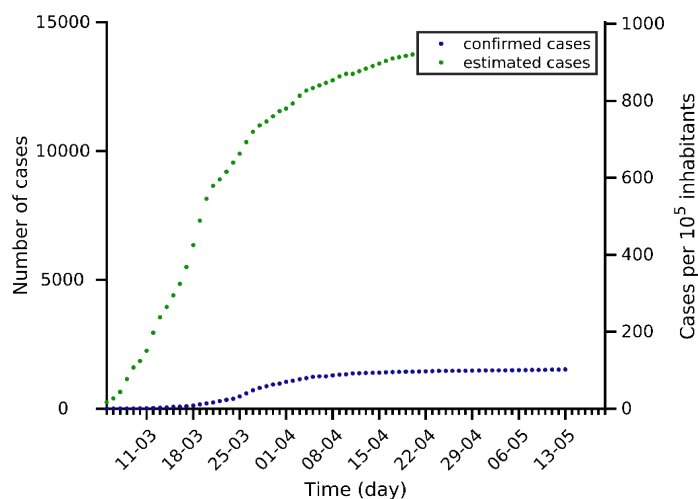
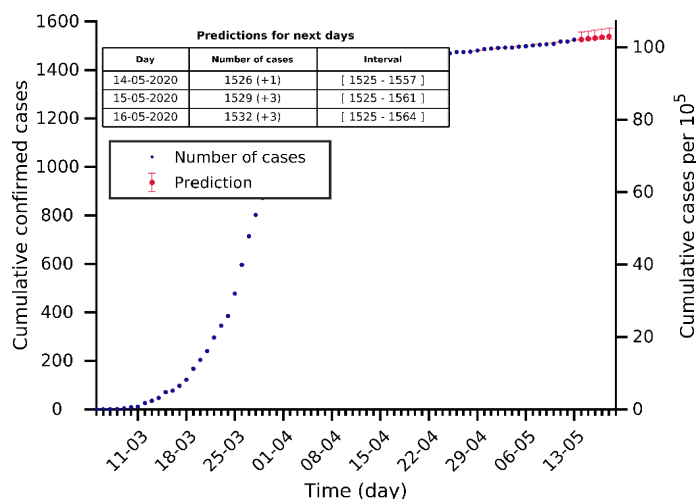
Cantabria 13-05-2020. Population: 0.6M. Current cumulated incidence: 388/10⁵



Baleares 13-05-2020. Population: 1.1M. Current cumulated incidence: 170/10⁵



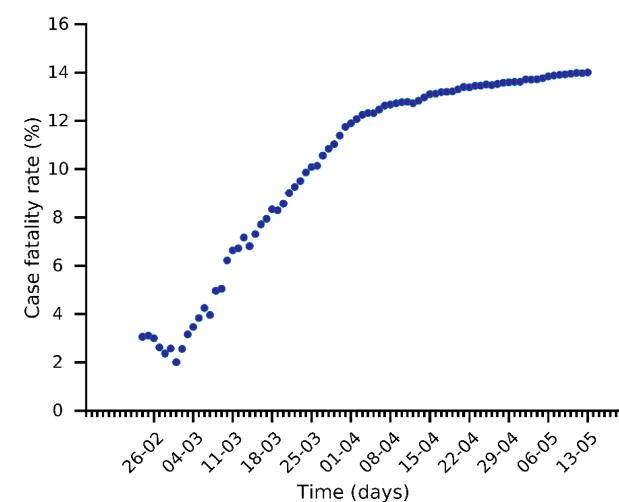
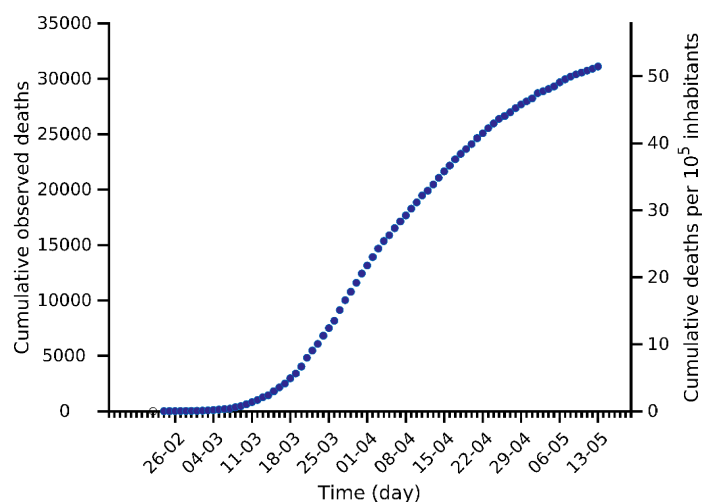
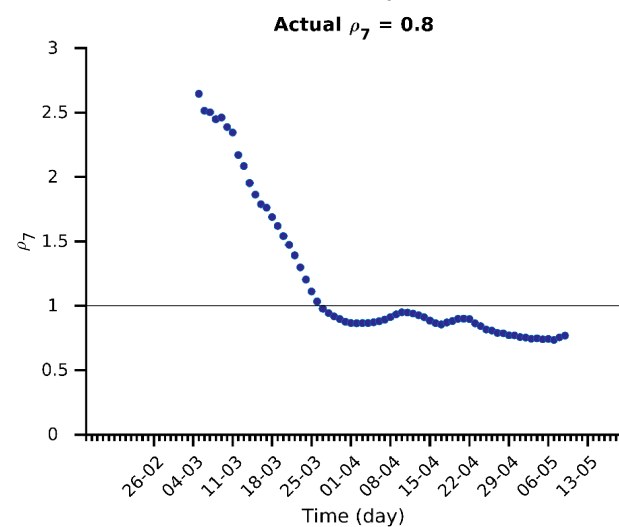
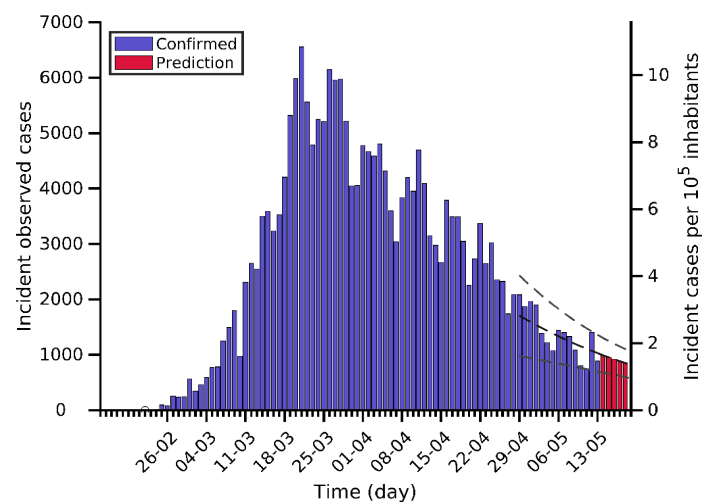
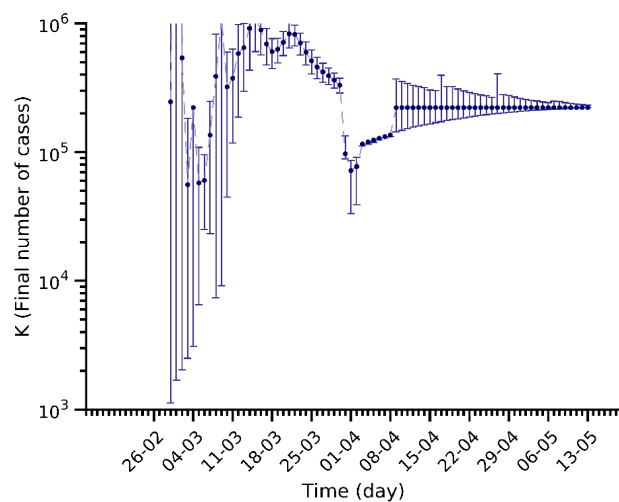
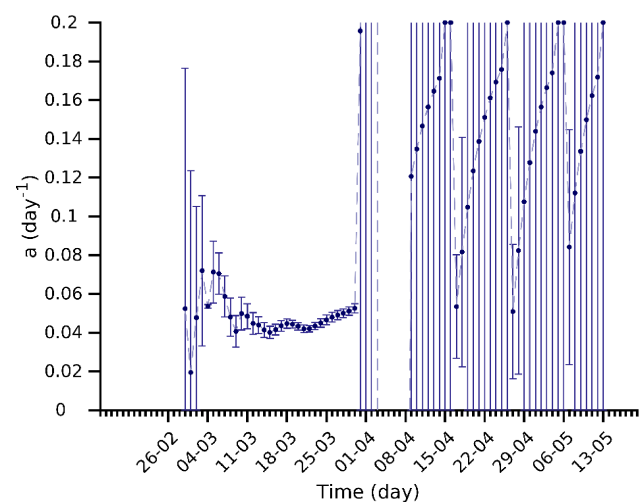
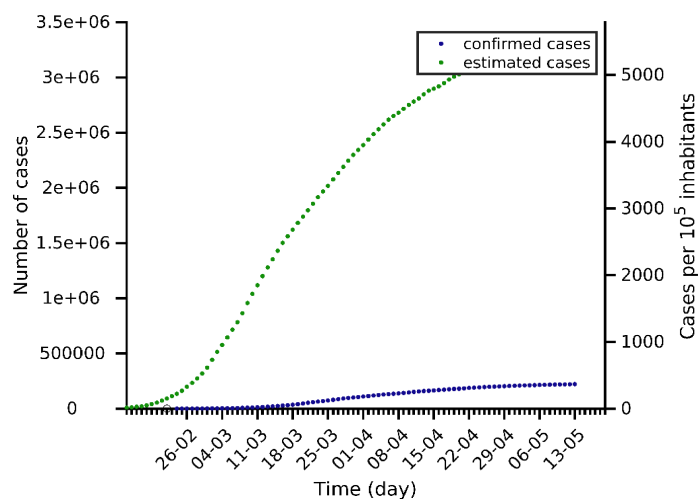
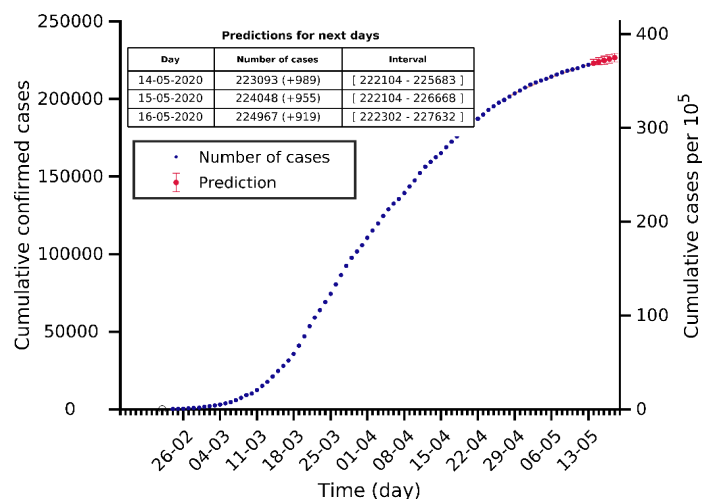
Murcia 13-05-2020. Population: 1.5M. Current cumulated incidence: 102/10⁵



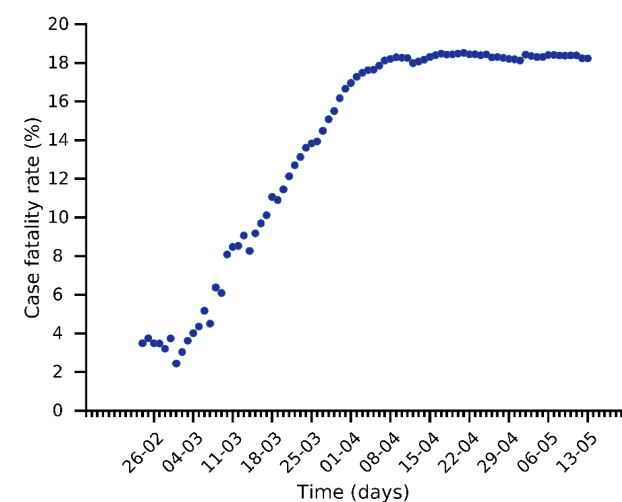
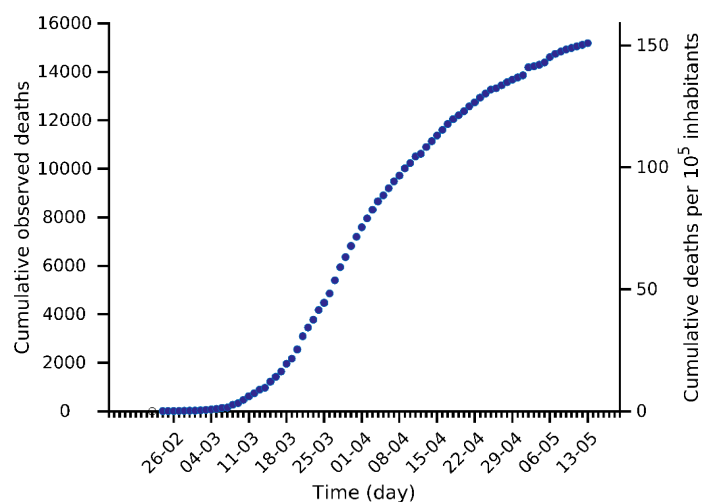
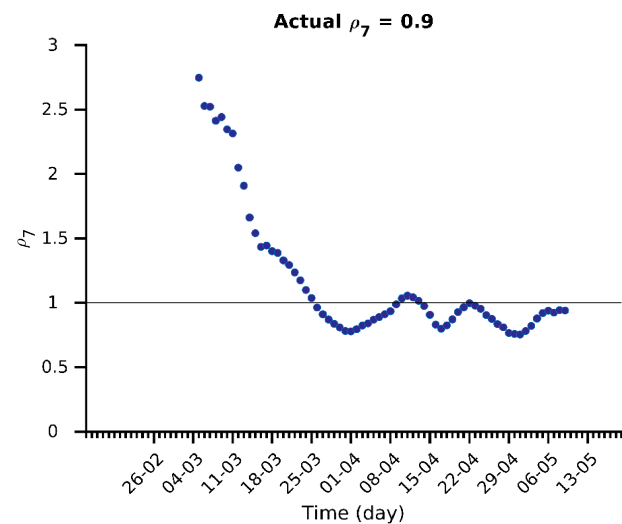
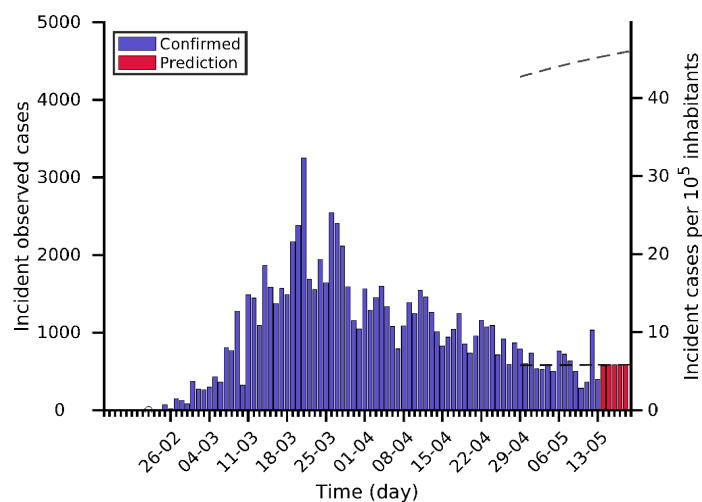
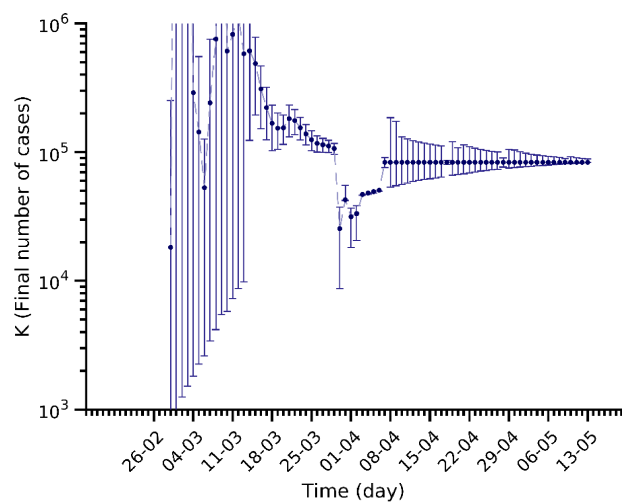
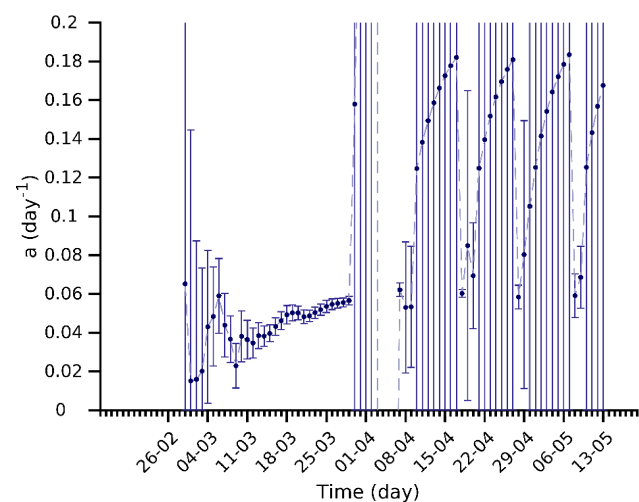
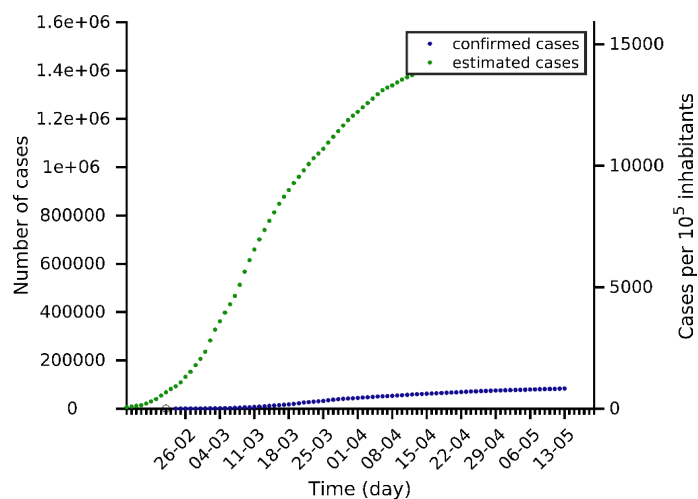
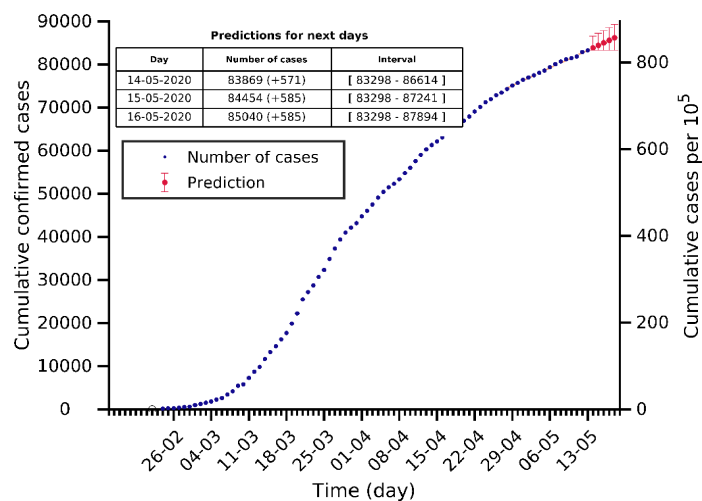
(4) Analysis and prediction of COVID-19 for Italy and its regions

Data obtained from: <https://github.com/pcm-dpc/COVID-19/tree/master/dati-andamento-nazionale>

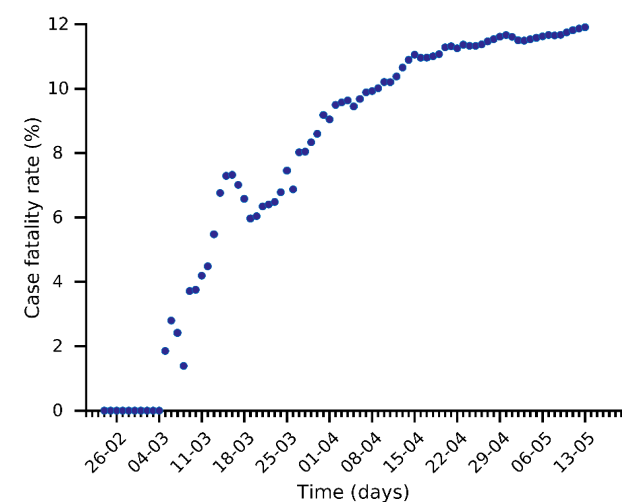
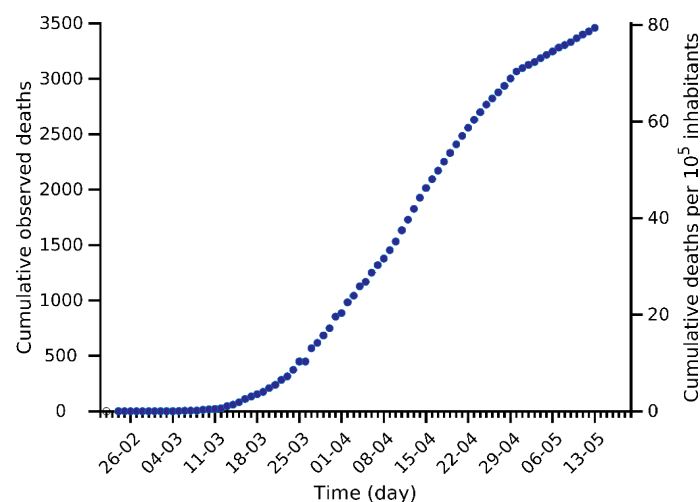
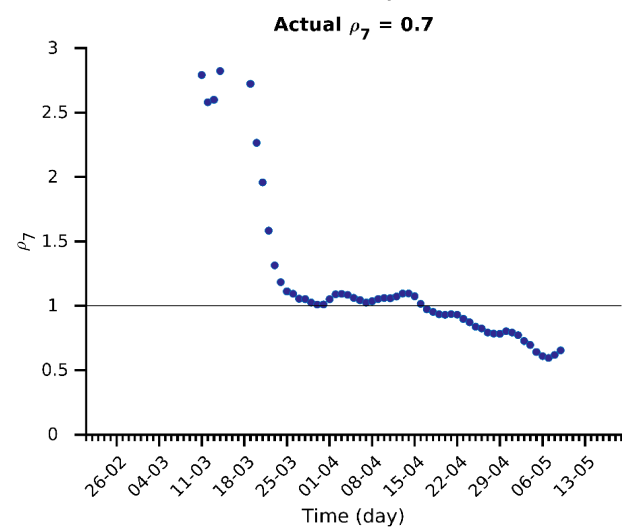
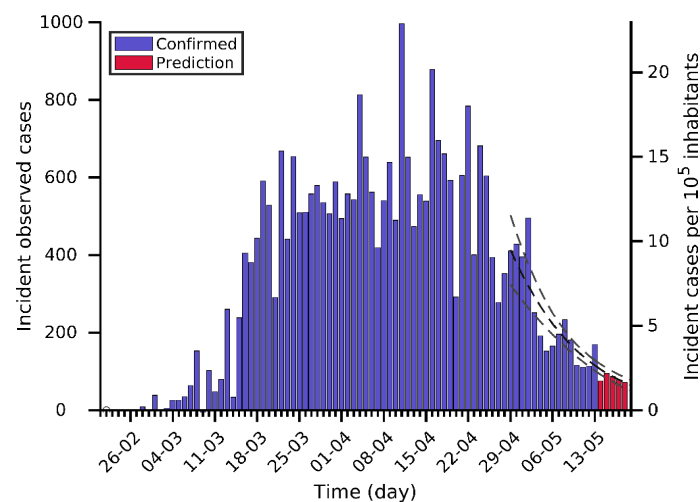
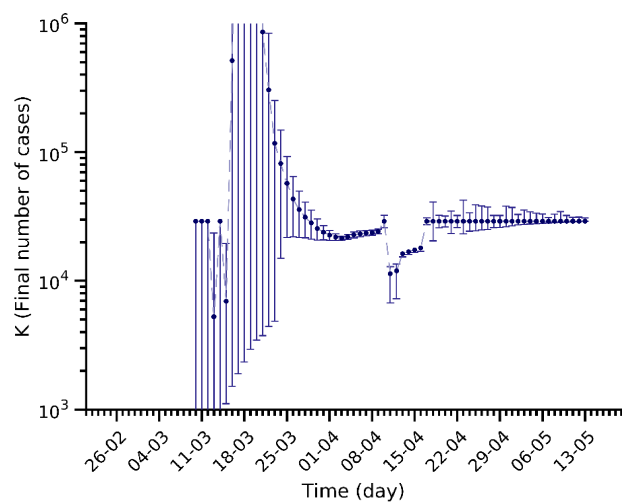
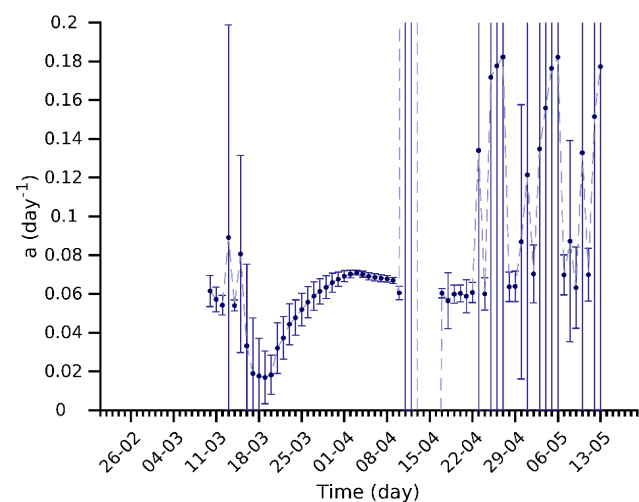
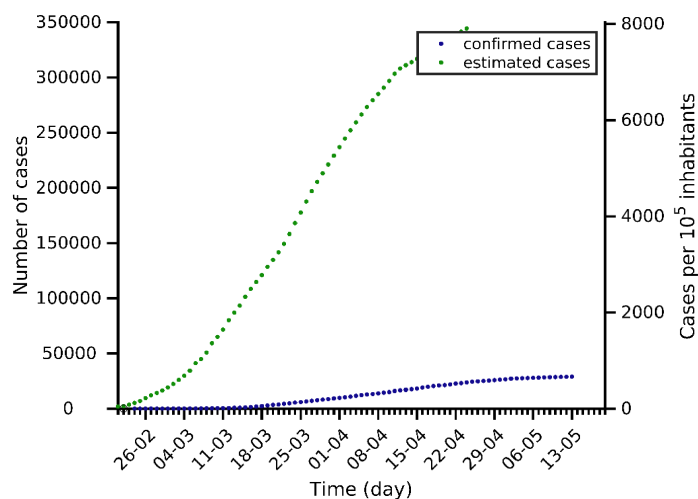
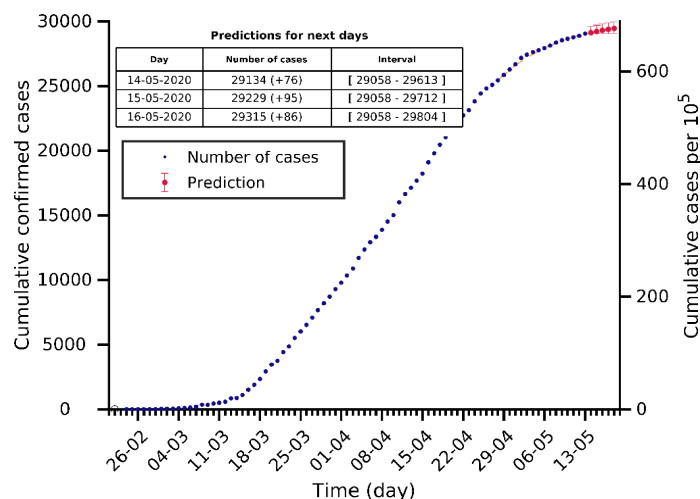
Italy 13-05-2020. Population: 60.5M. Current cumulated incidence: 367/10⁵



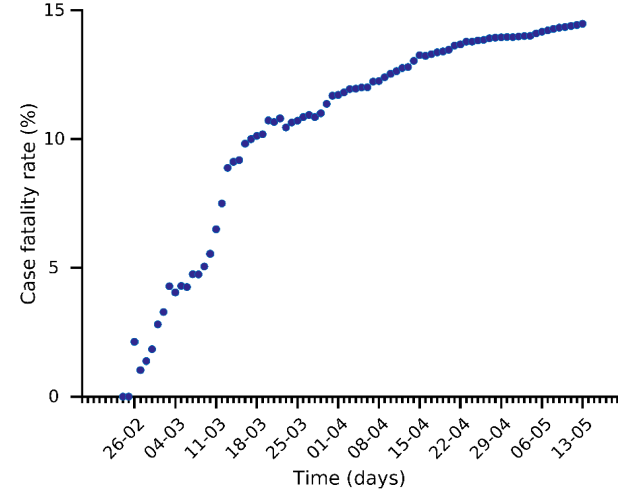
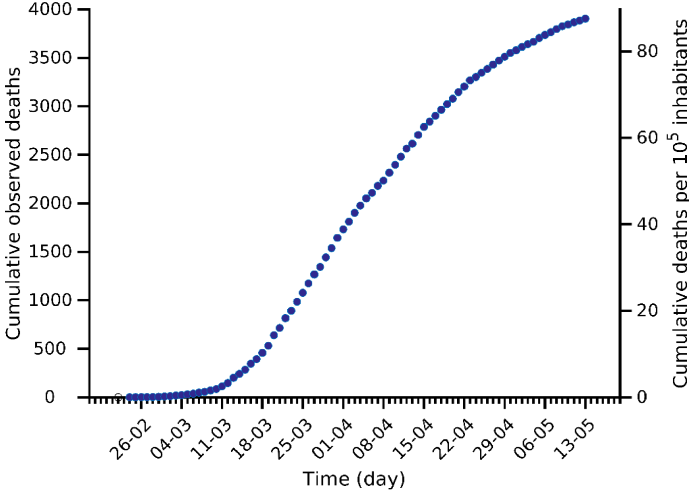
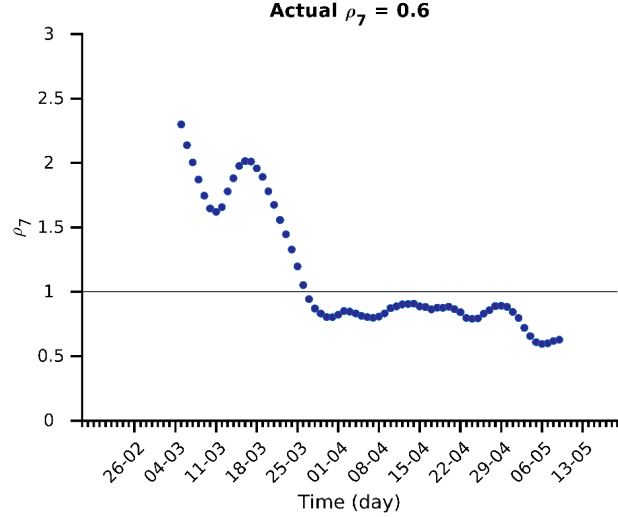
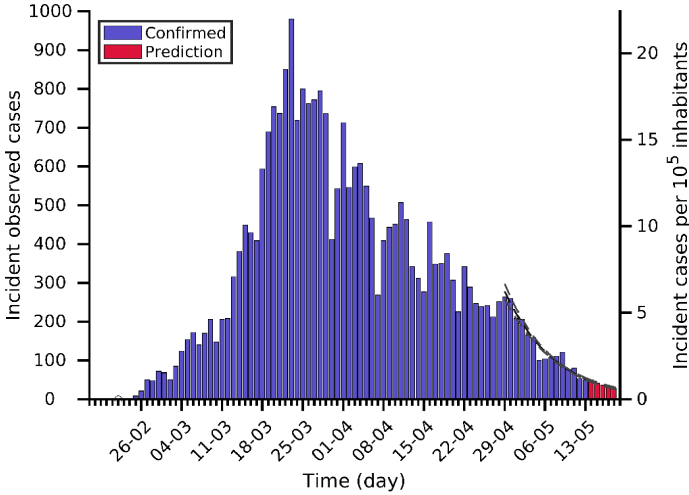
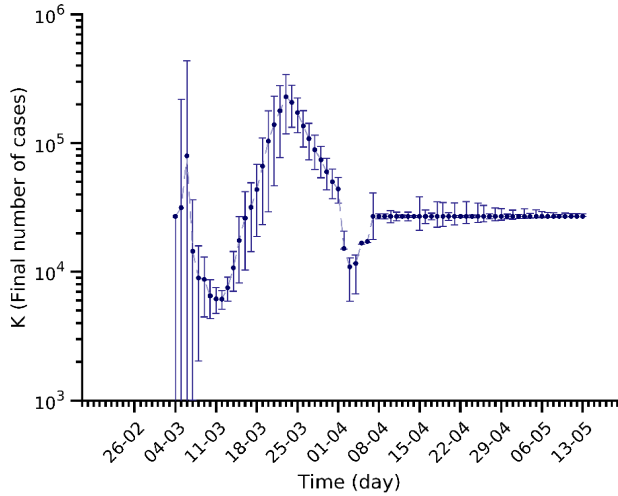
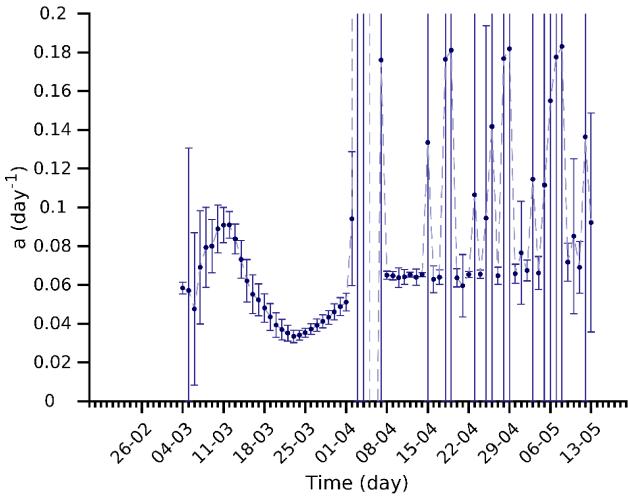
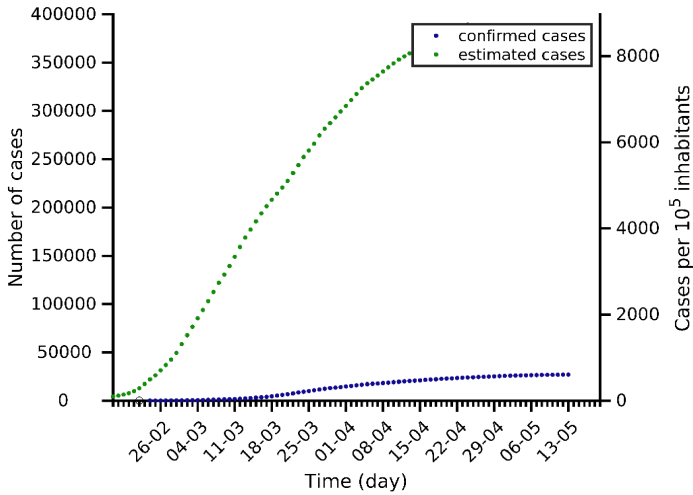
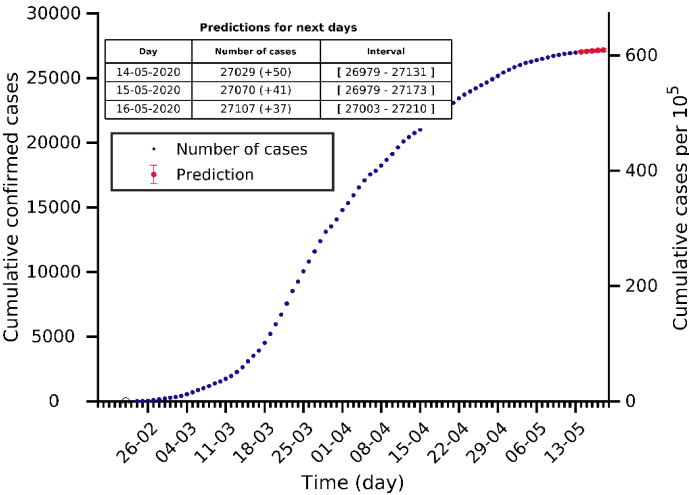
Lombardia 13-05-2020. Population: 10.1M. Current cumulated incidence: 828/10⁵



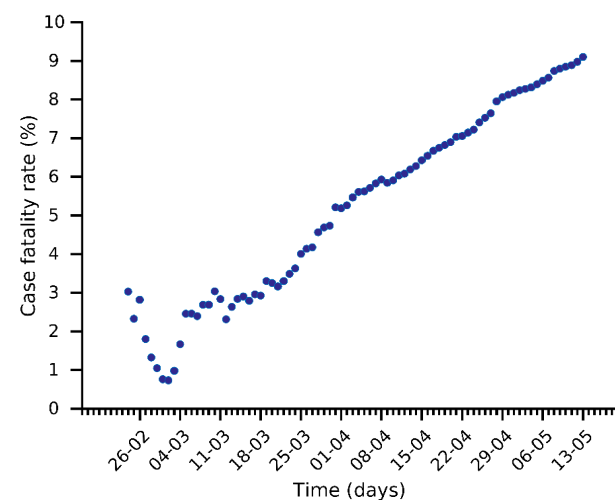
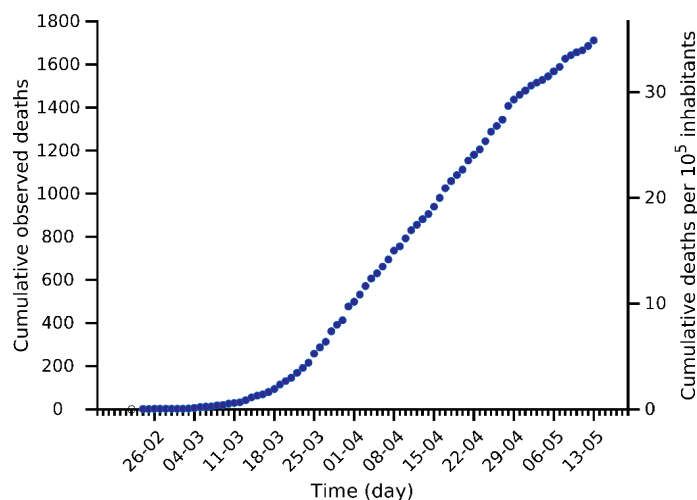
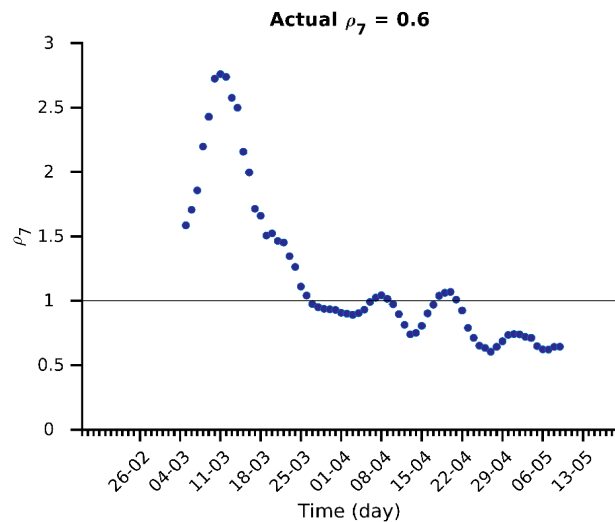
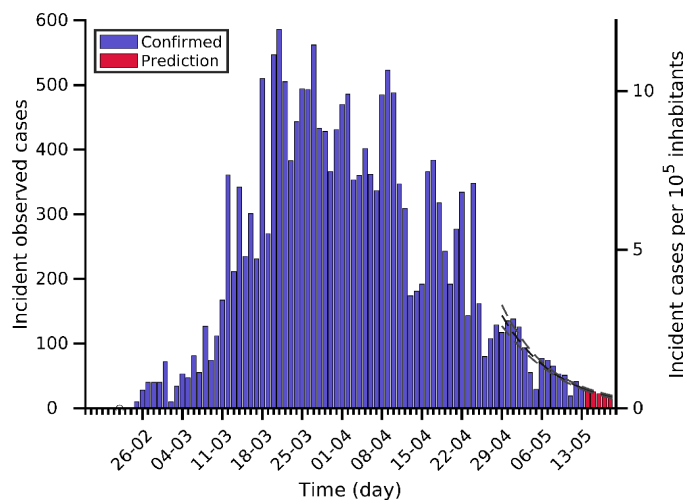
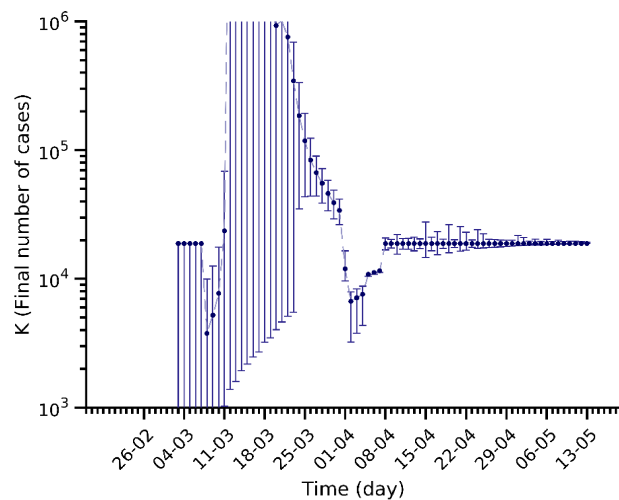
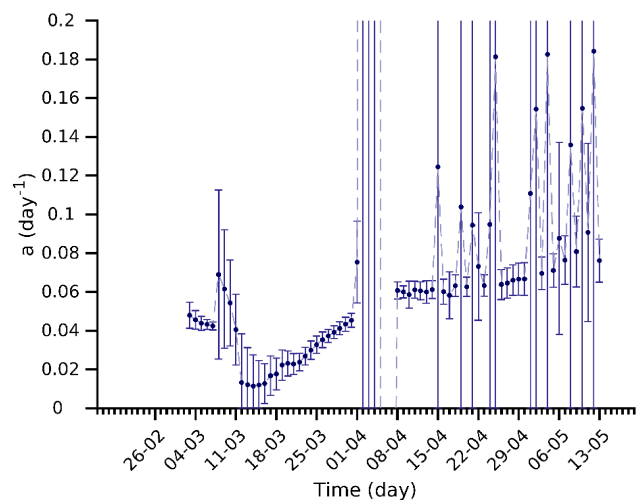
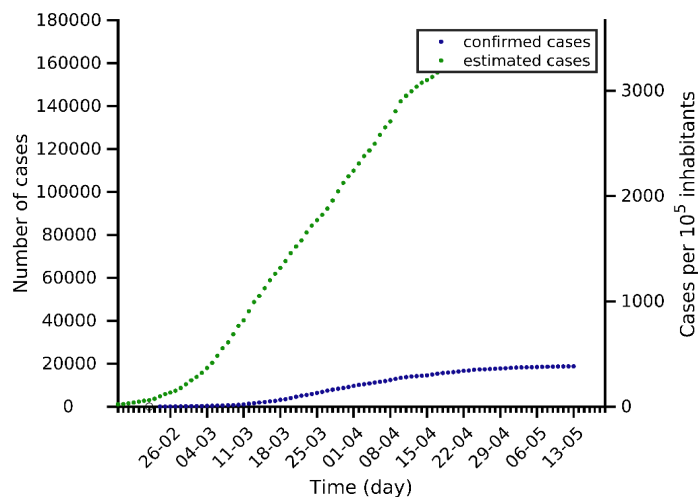
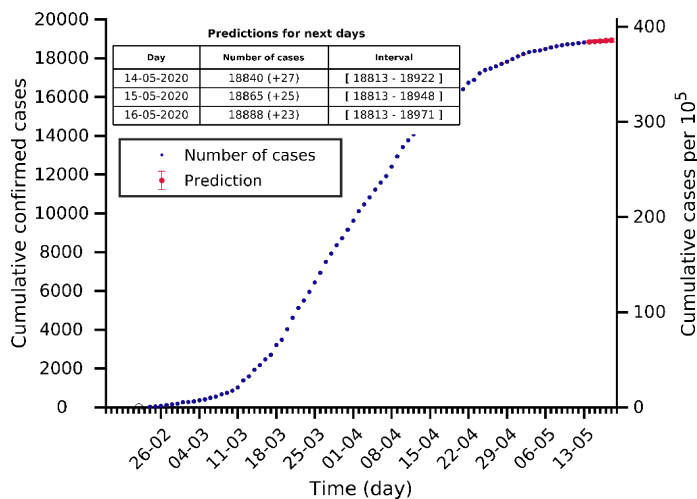
Piemonte 13-05-2020. Population: 4.4M. Current cumulated incidence: 667/10⁵



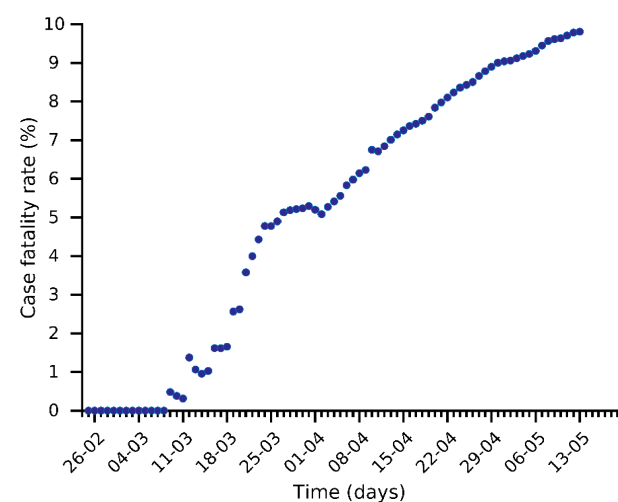
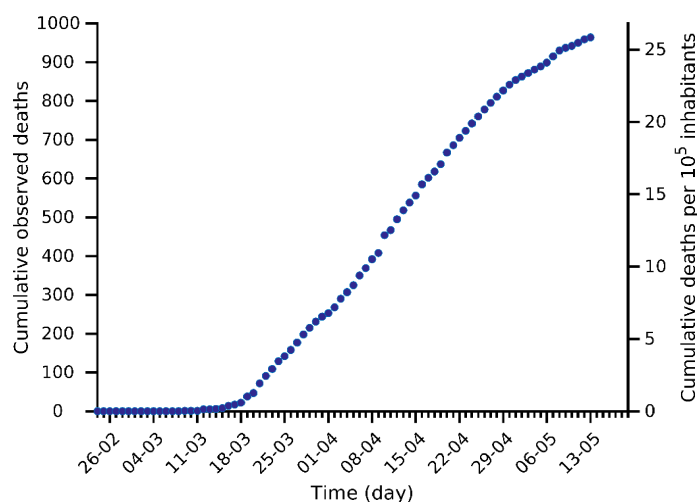
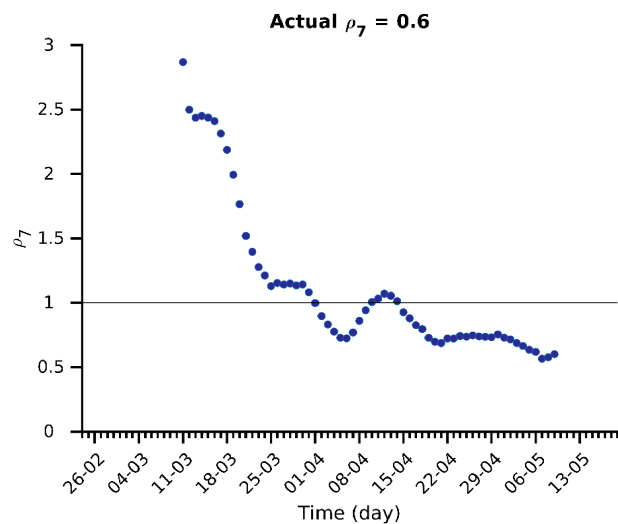
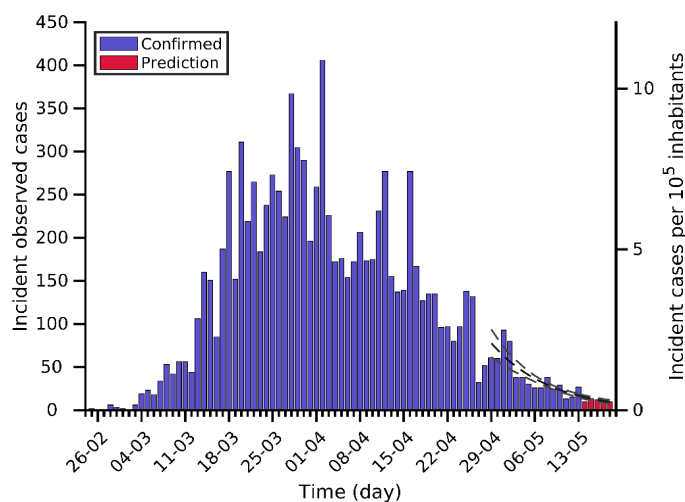
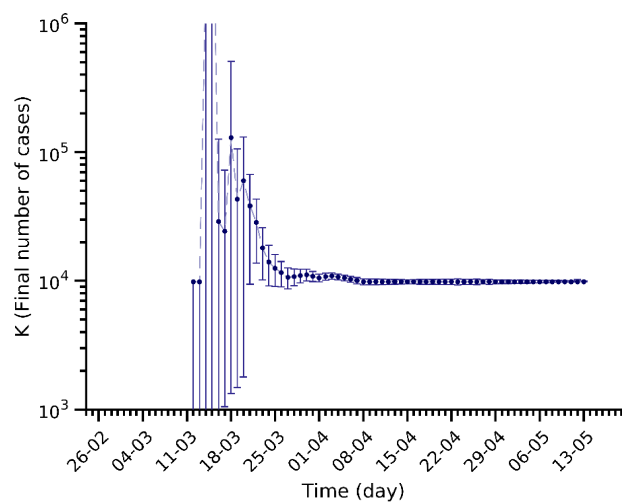
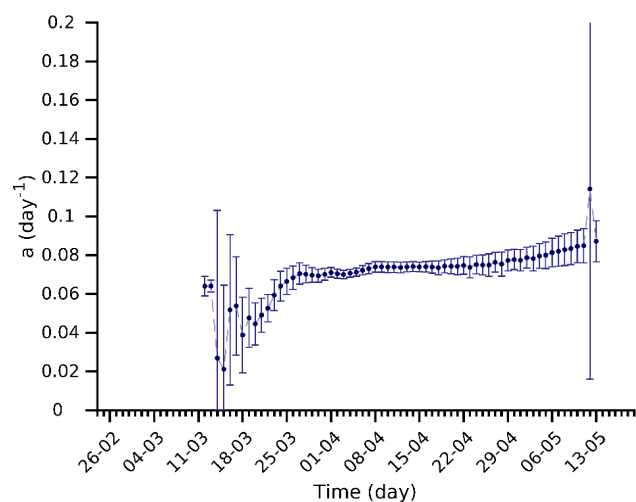
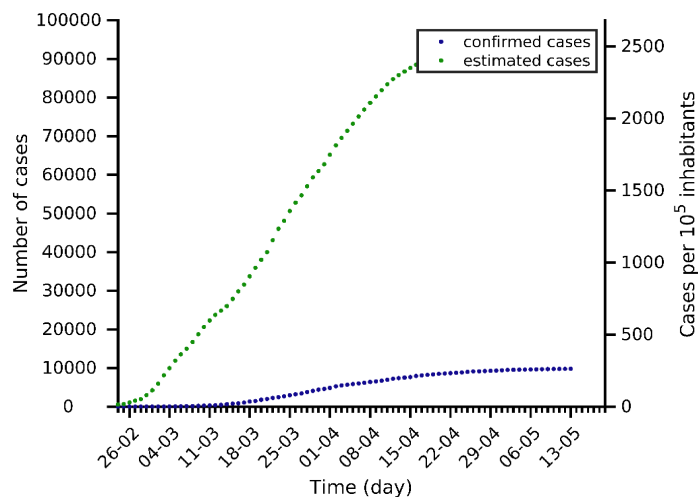
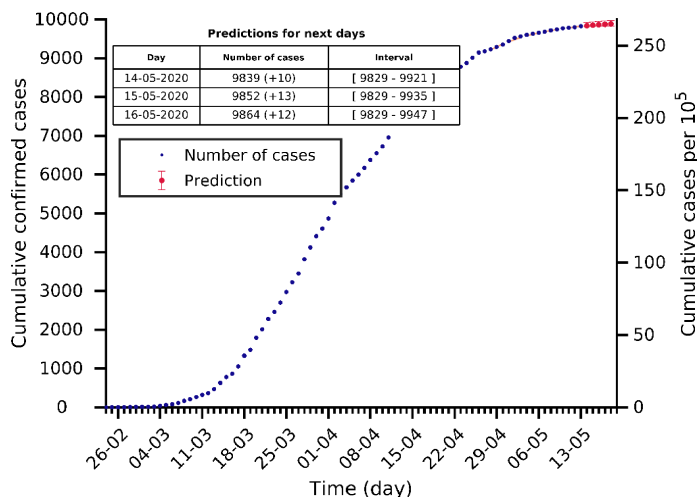
Emilia Romagna 13-05-2020. Population: 4.5M. Current cumulated incidence: 605/100000



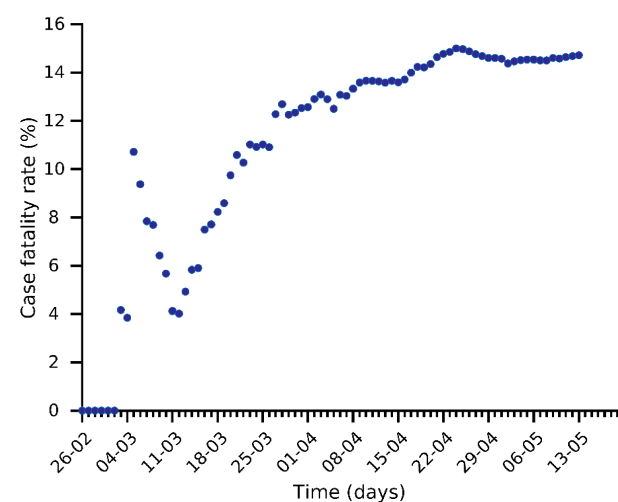
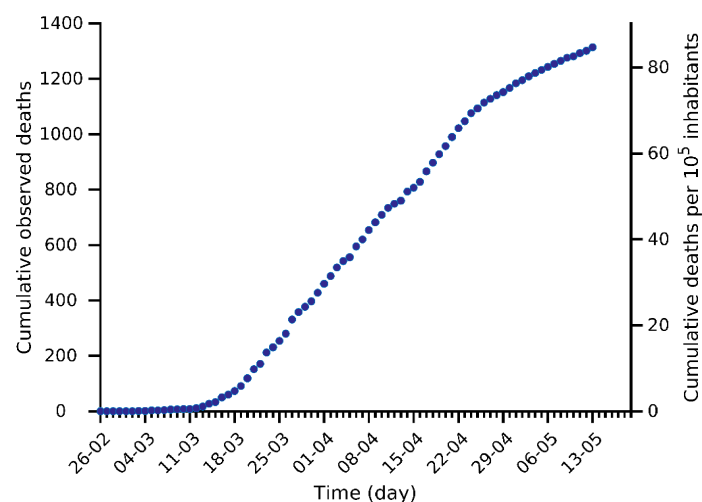
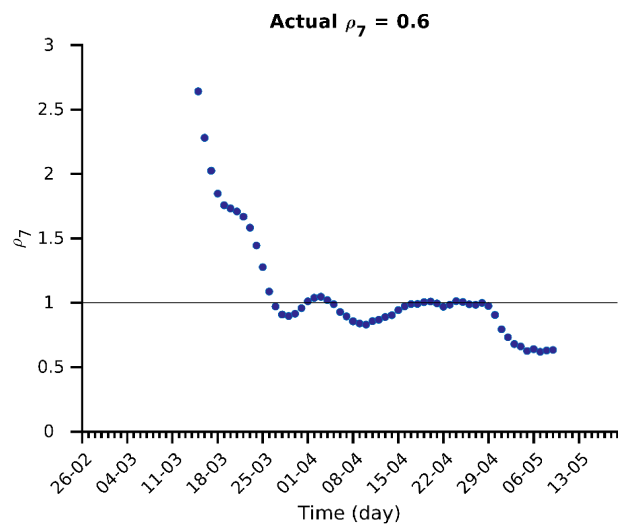
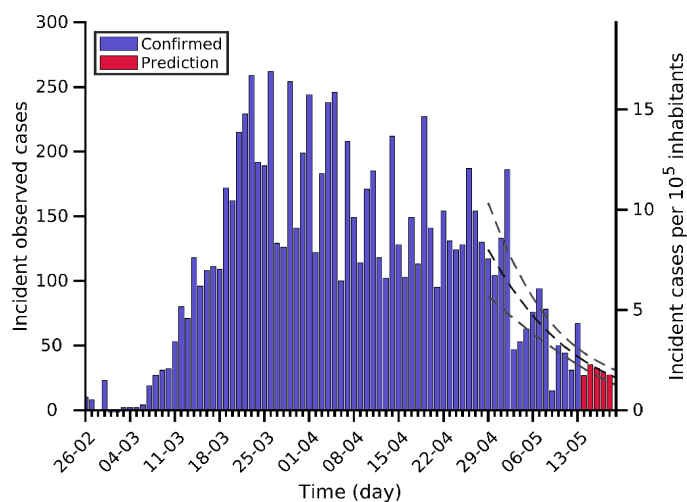
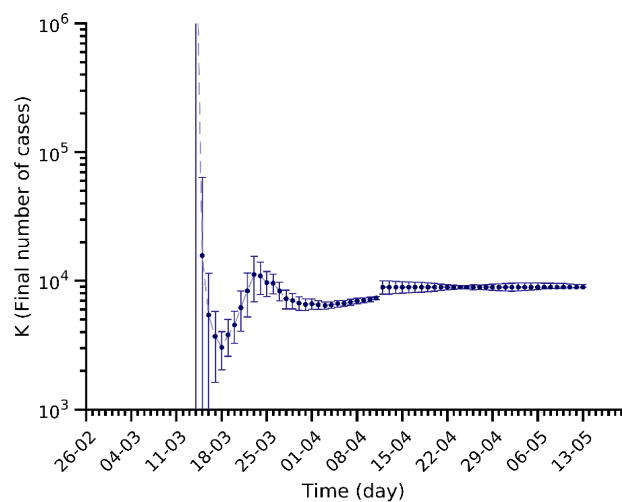
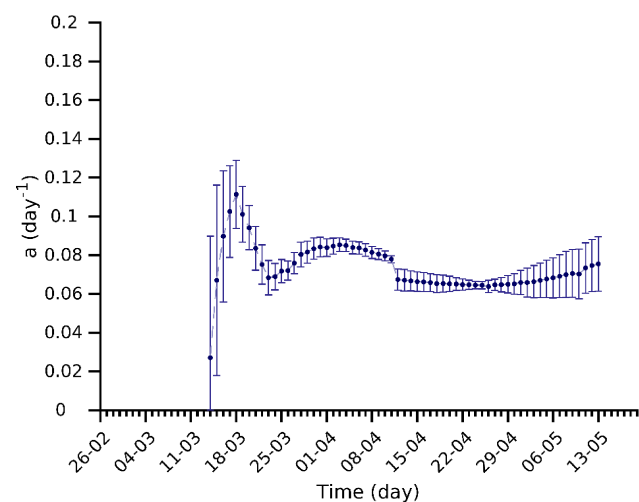
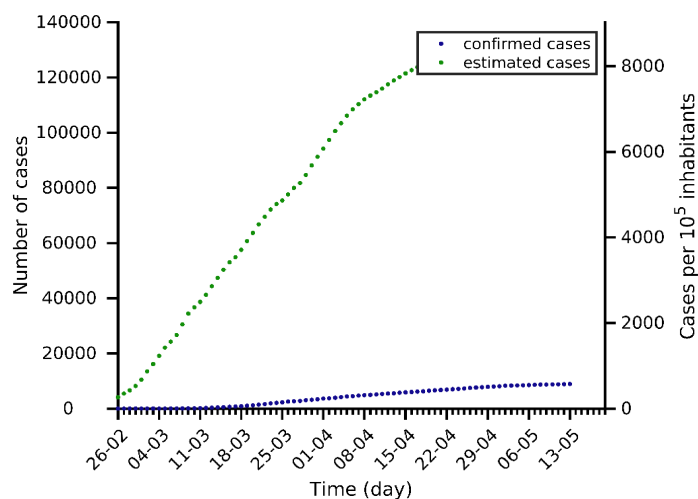
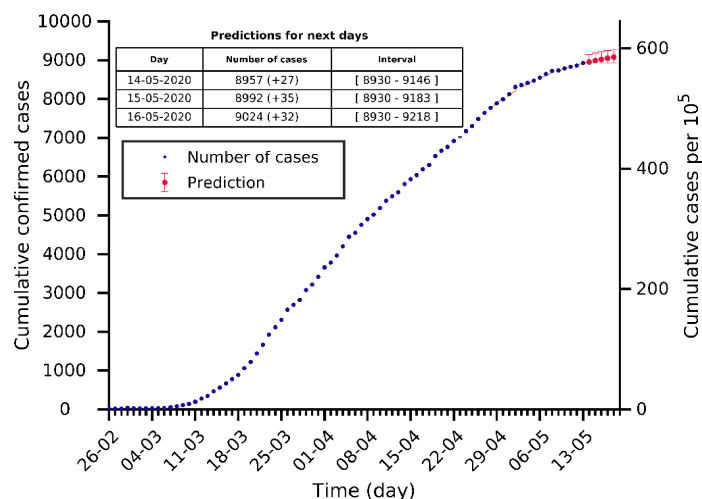
Veneto 13-05-2020. Population: 4.9M. Current cumulated incidence: 383/10⁵



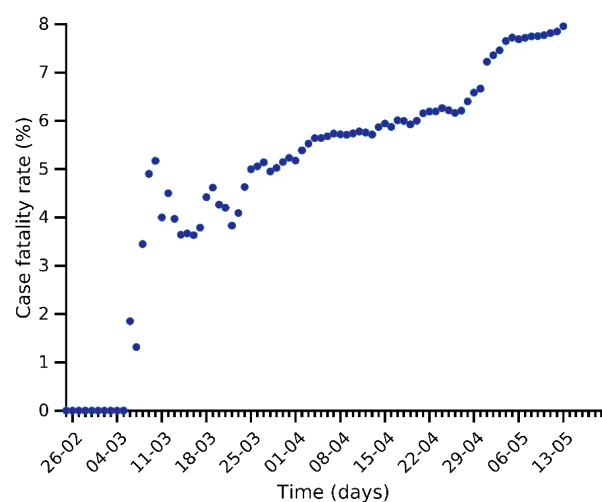
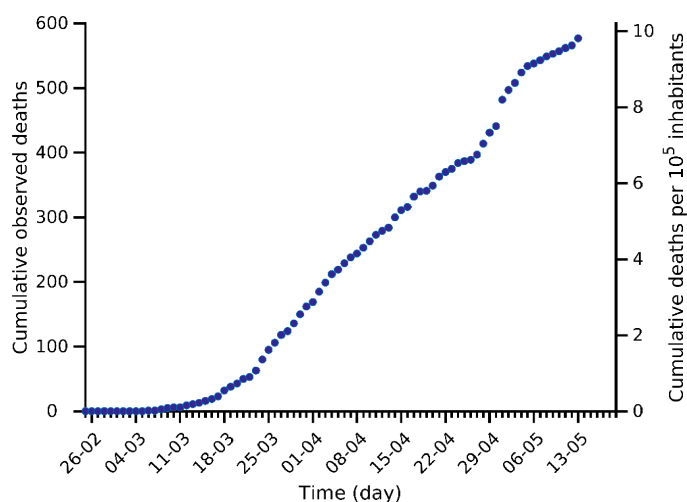
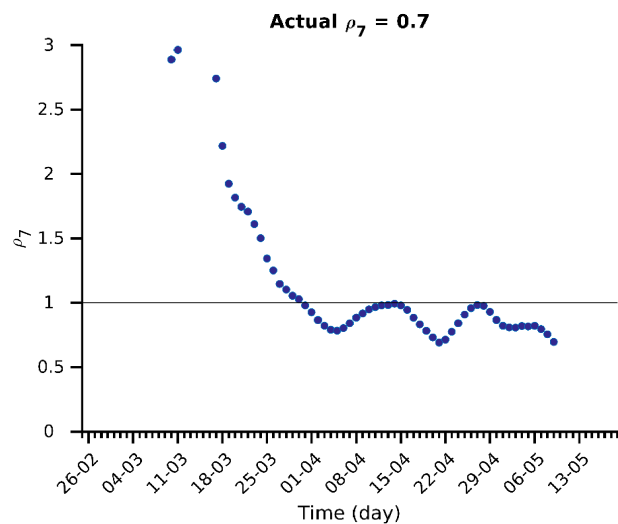
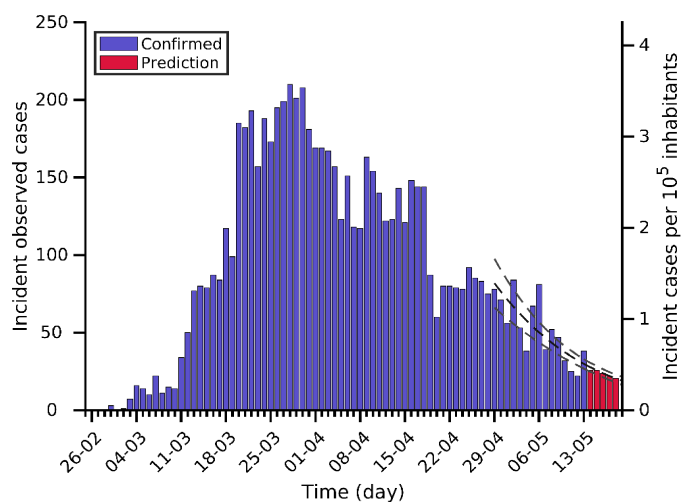
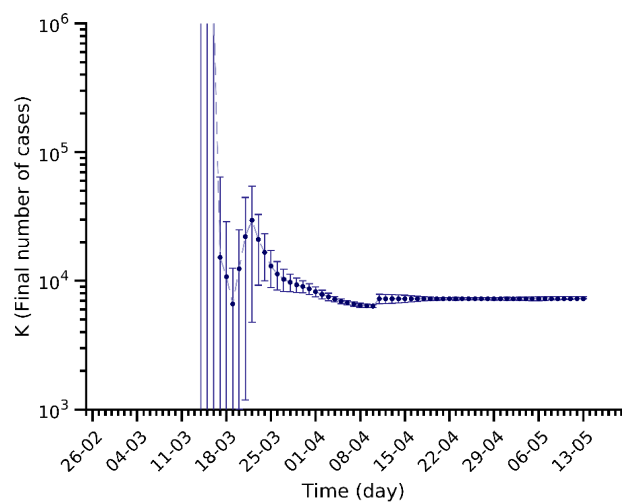
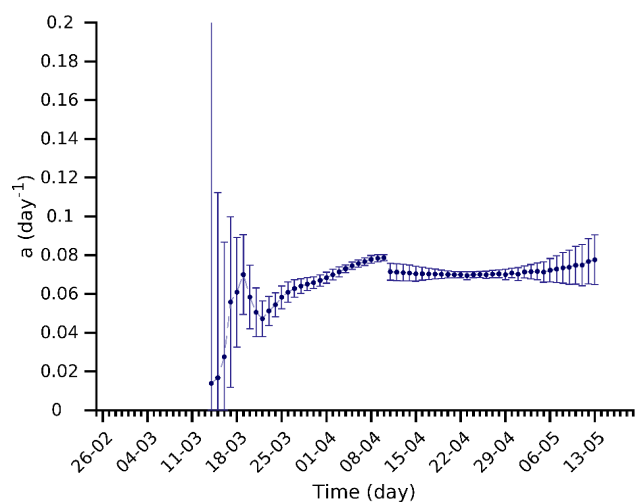
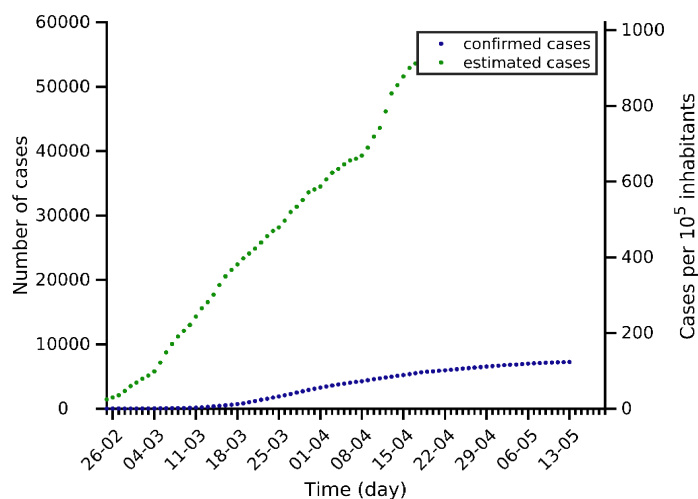
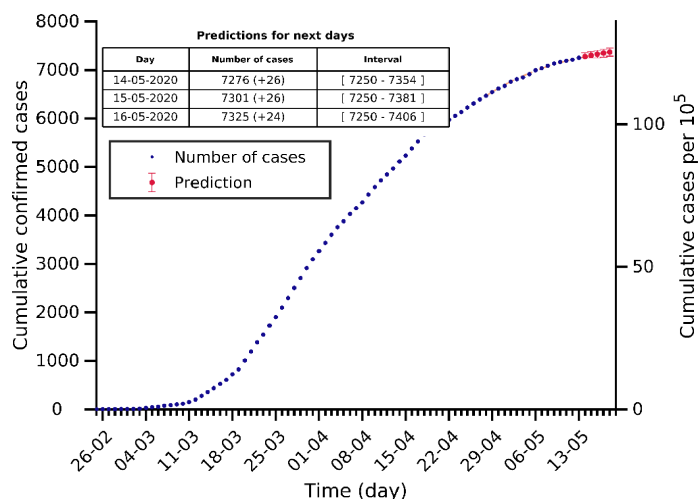
Toscana 13-05-2020. Population: 3.7M. Current cumulated incidence: 264/10⁵



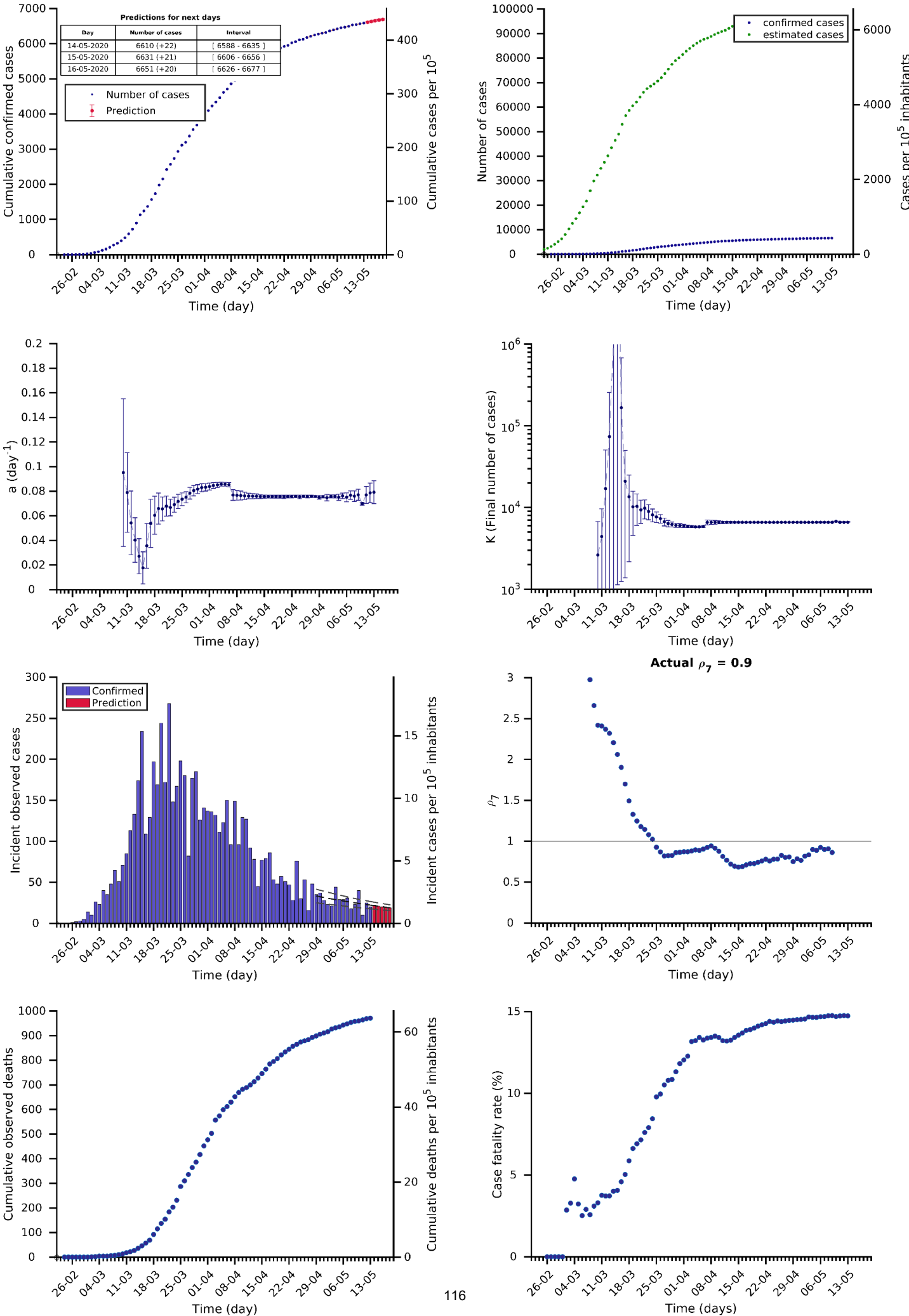
Liguria 13-05-2020. Population: 1.6M. Current cumulated incidence: 576/10⁵



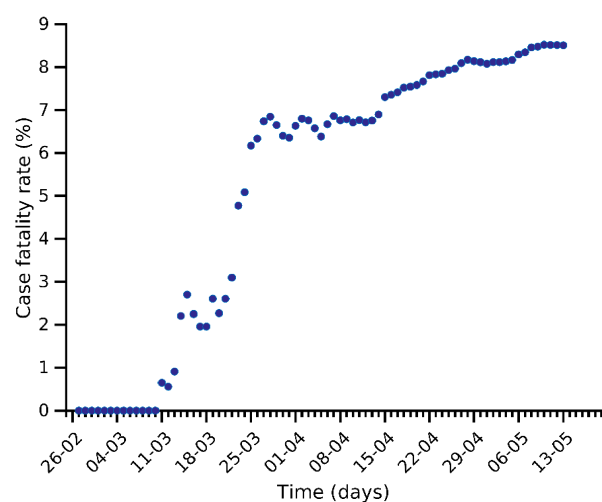
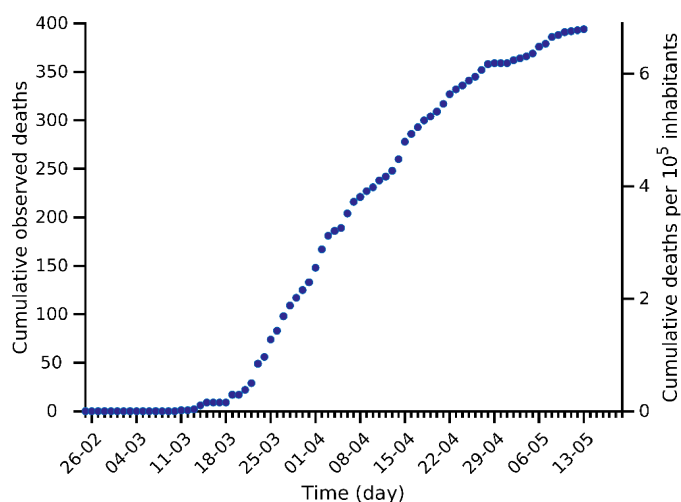
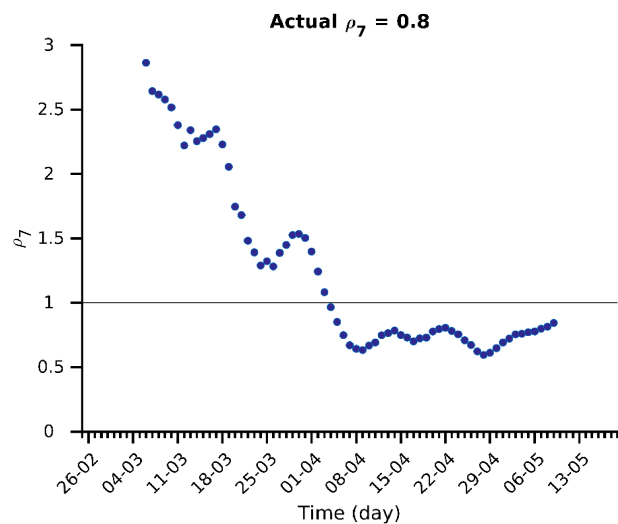
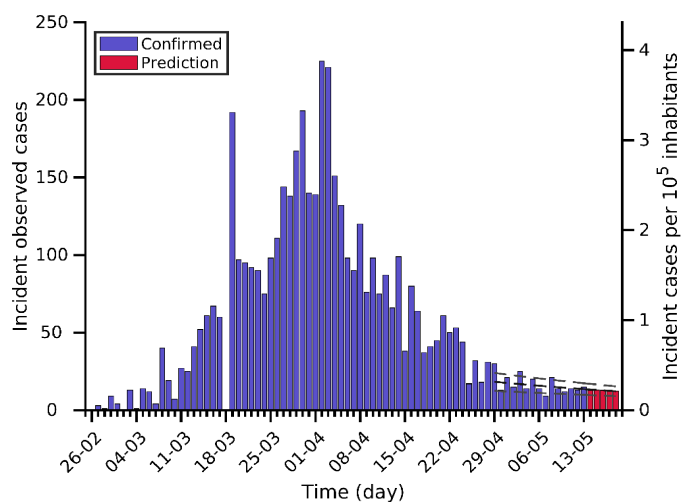
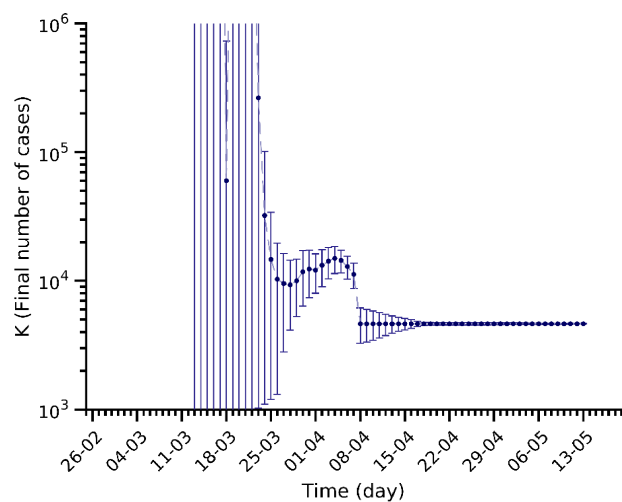
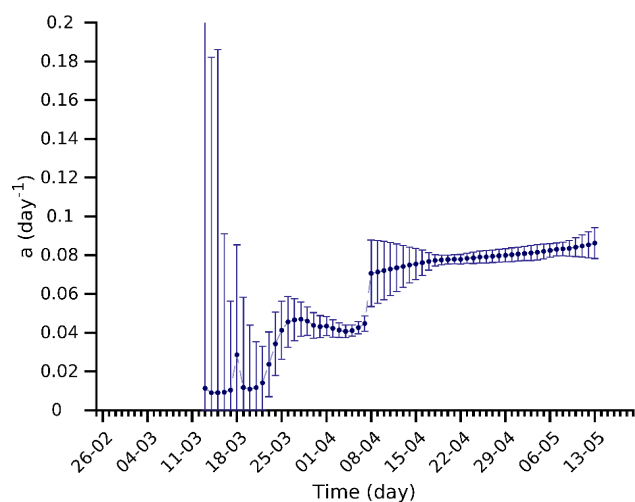
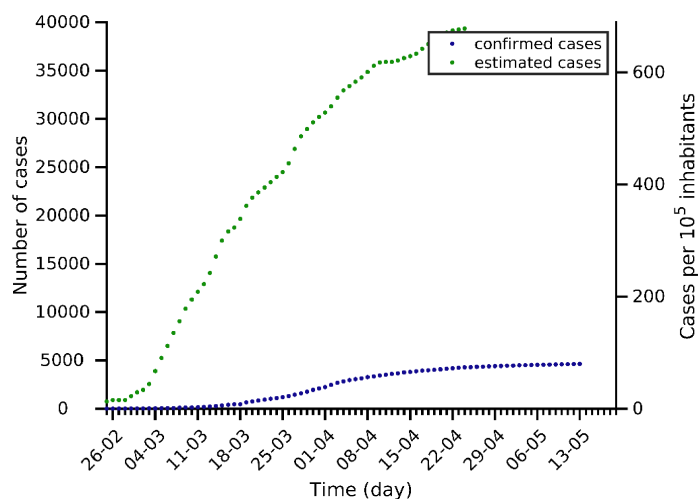
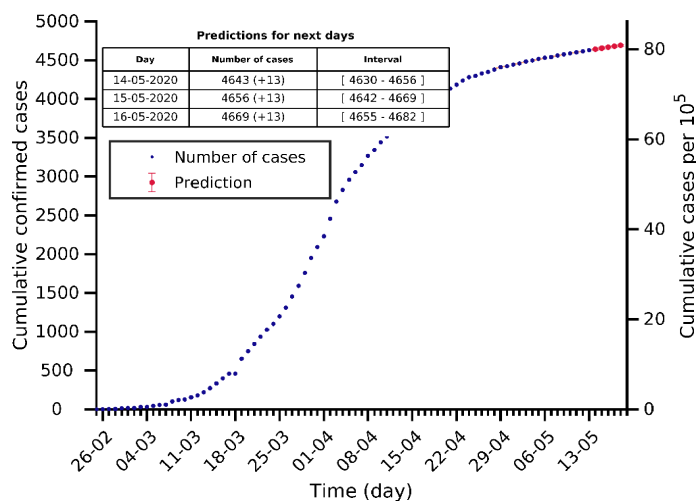
Lazio 13-05-2020. Population: 5.9M. Current cumulated incidence: 123/10⁵



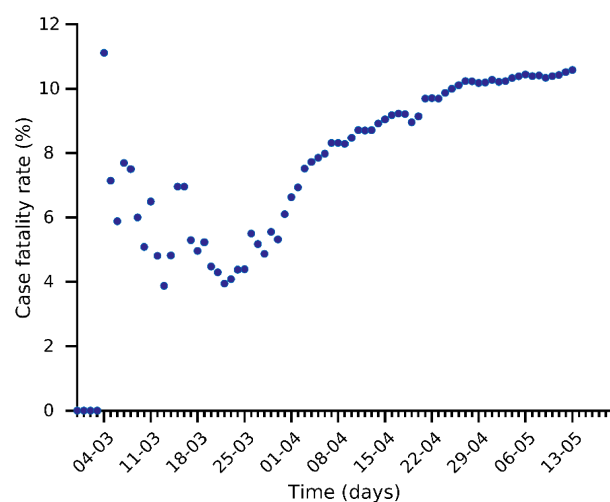
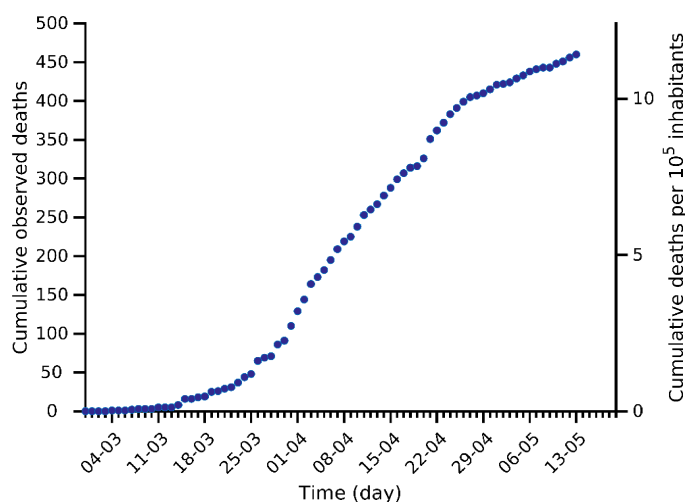
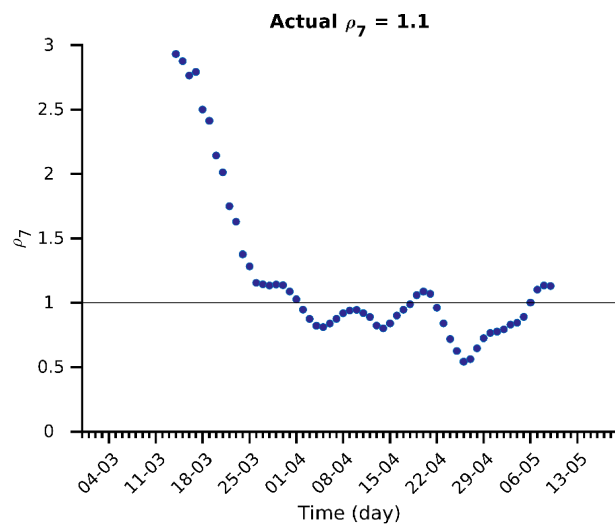
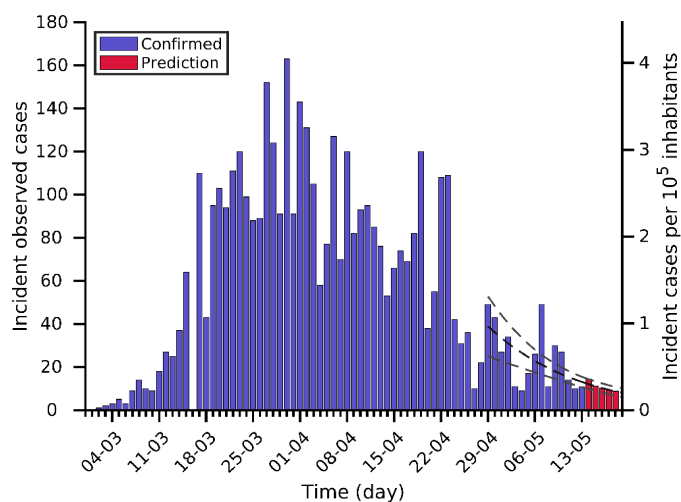
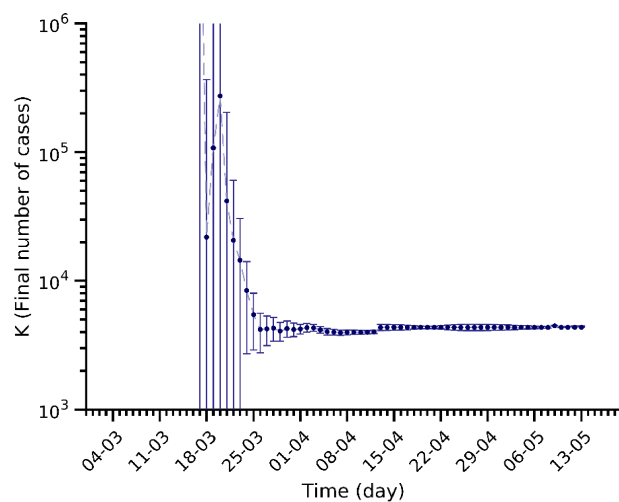
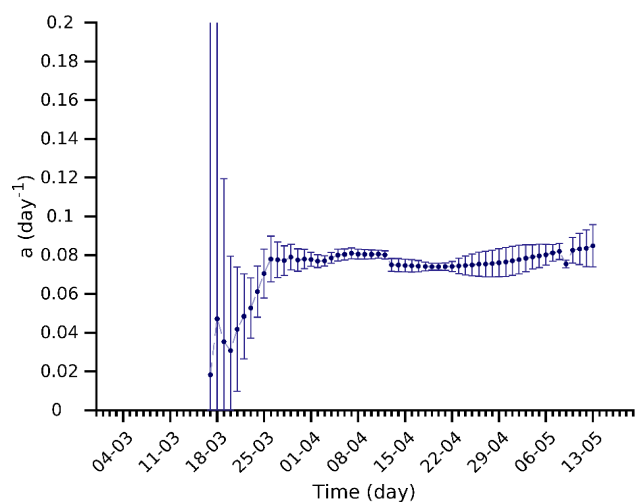
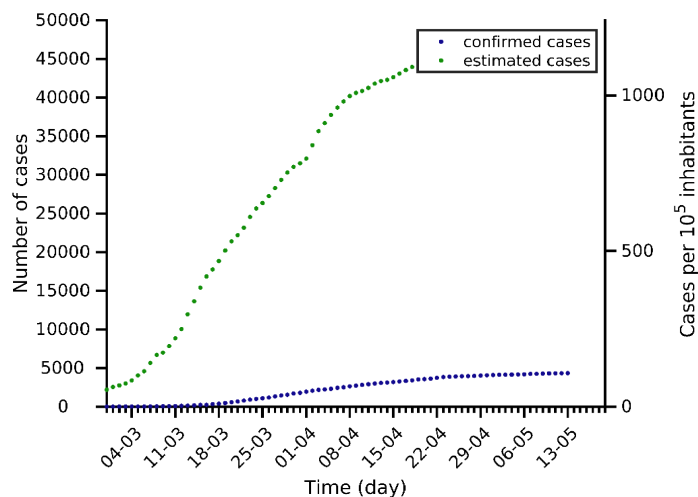
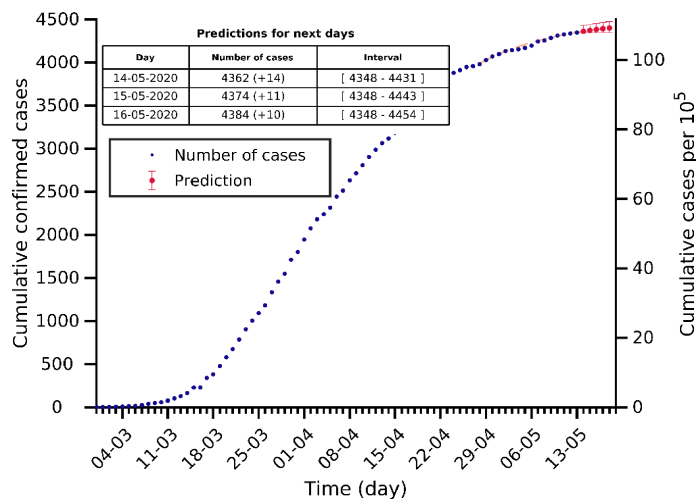
Marche
 13-05-2020.
 Population: 1.5M.
 Current cumulated incidence: 432/10⁵



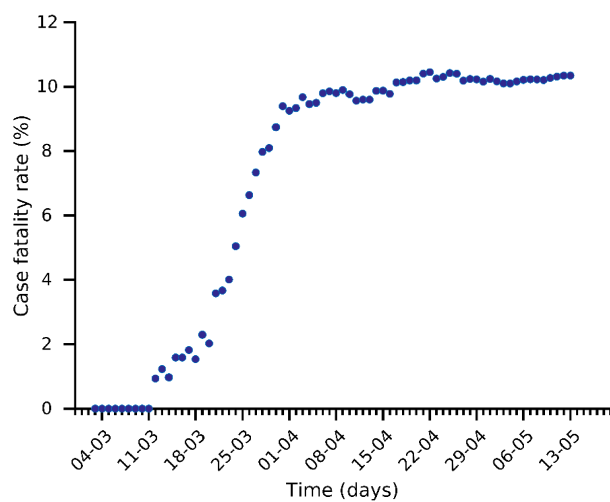
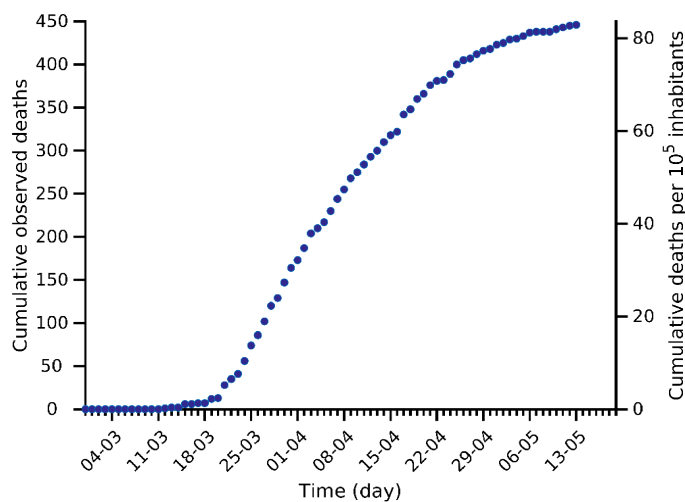
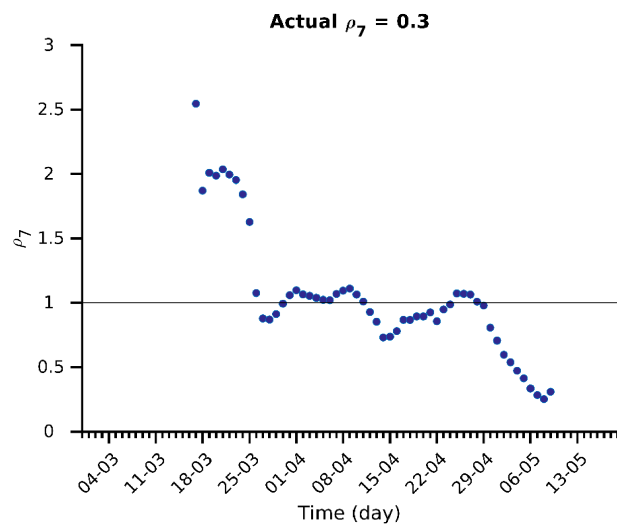
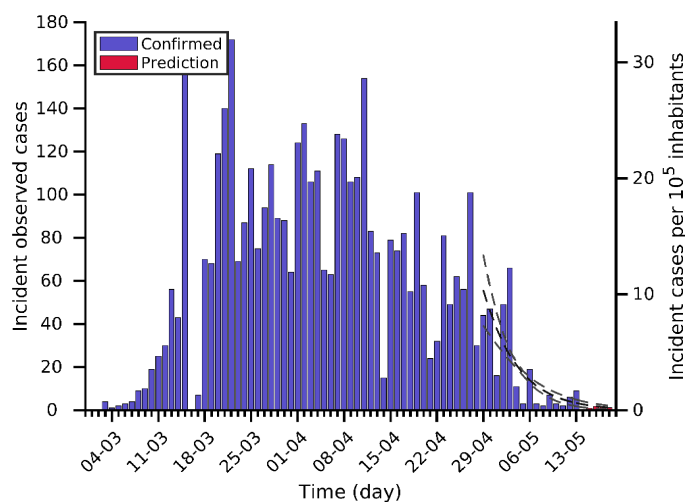
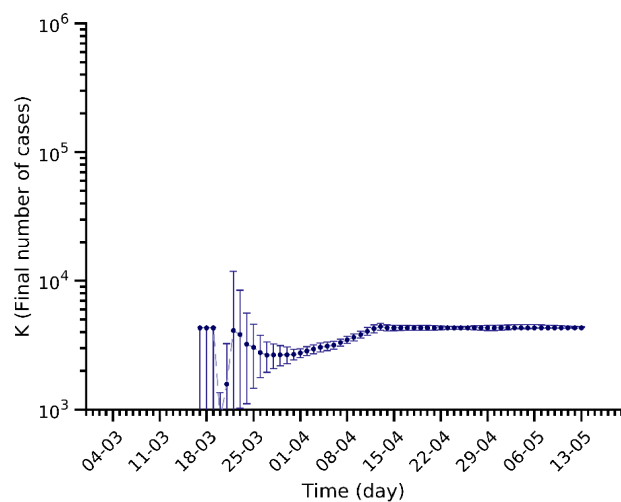
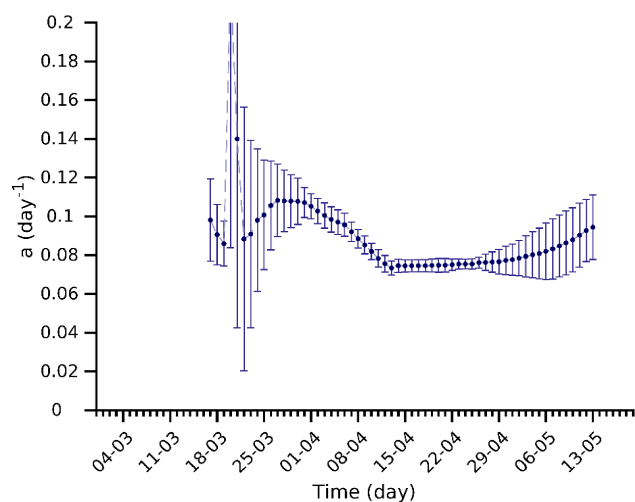
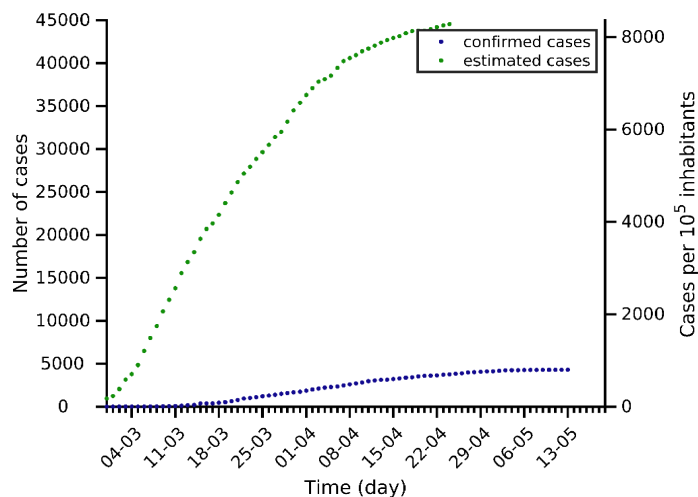
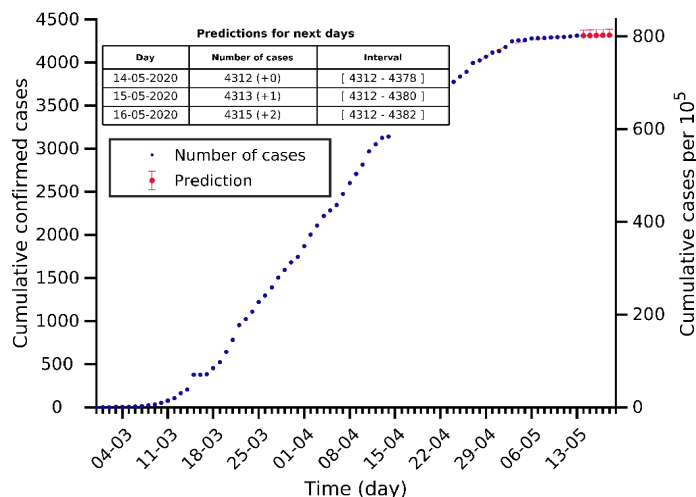
Campania 13-05-2020. Population: 5.8M. Current cumulated incidence: 80/10⁵



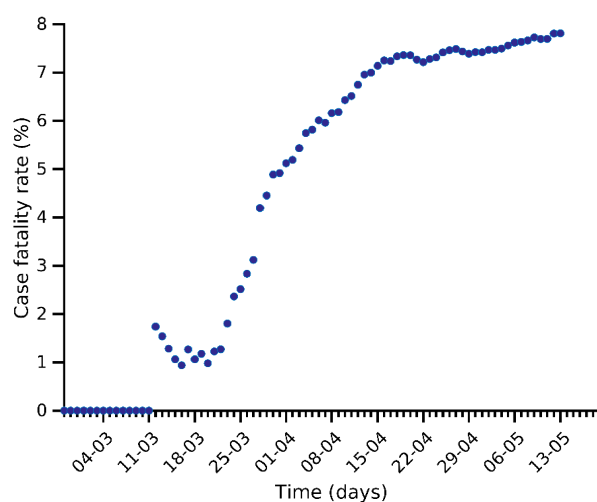
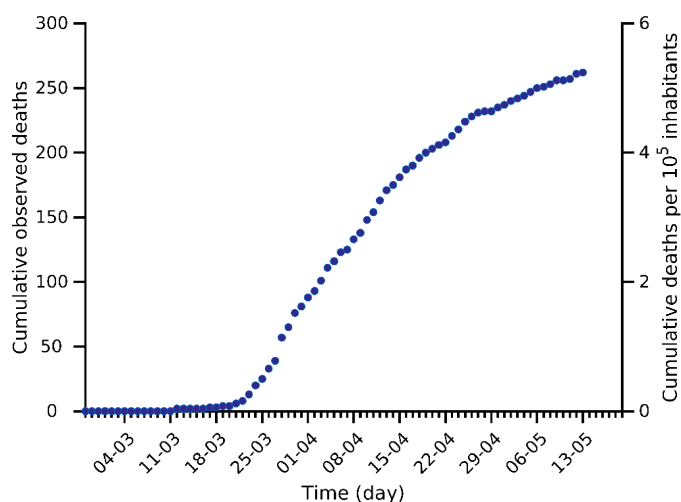
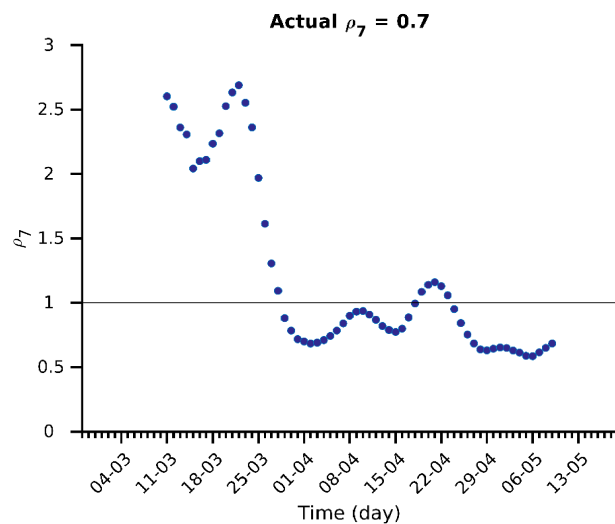
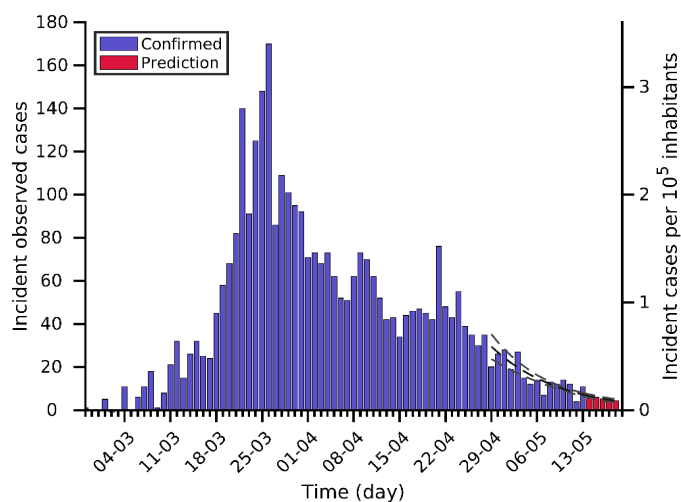
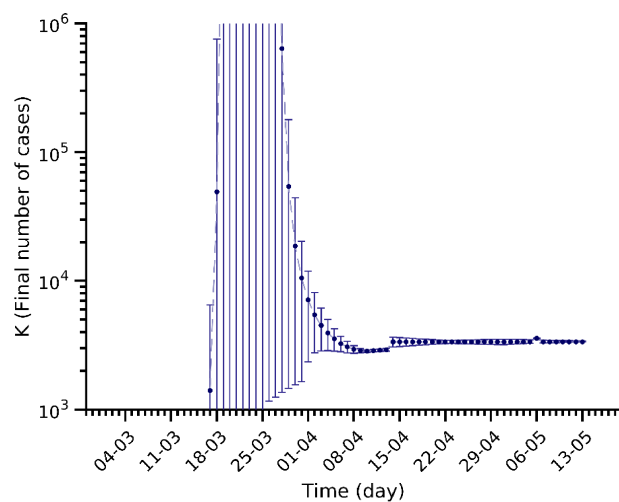
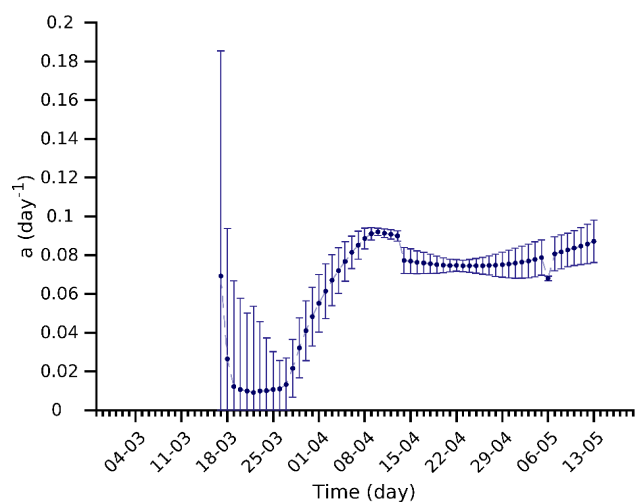
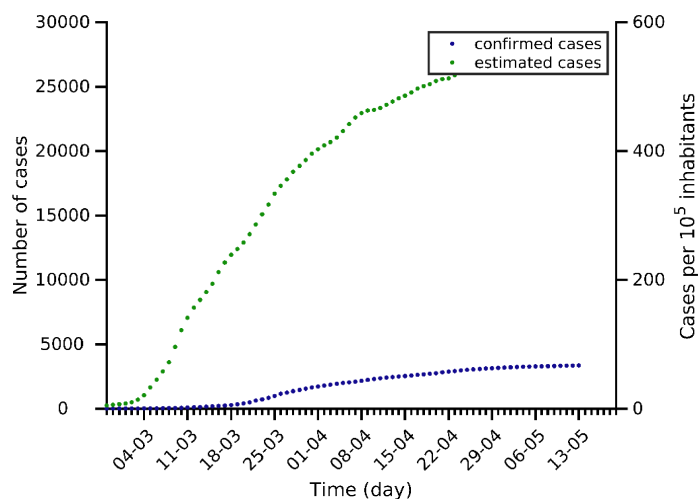
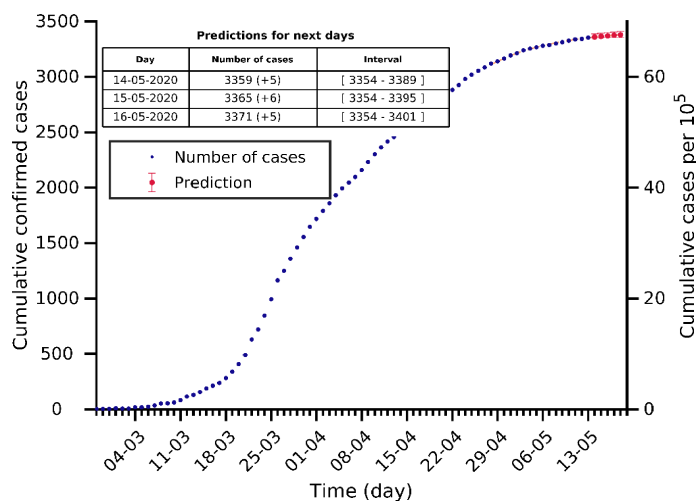
Puglia 13-05-2020. Population: 4.0M. Current cumulated incidence: 108/10⁵



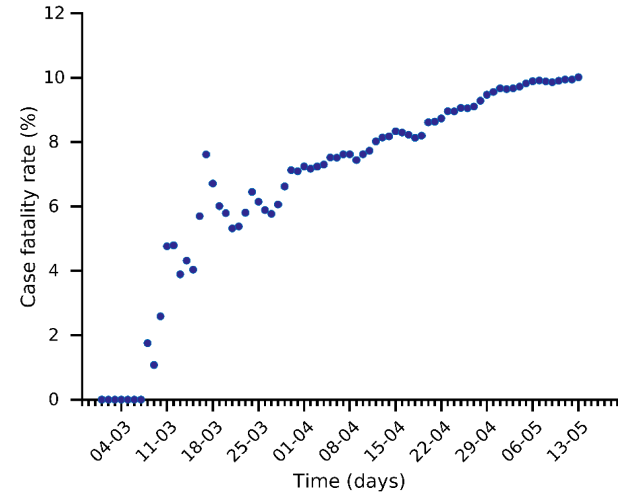
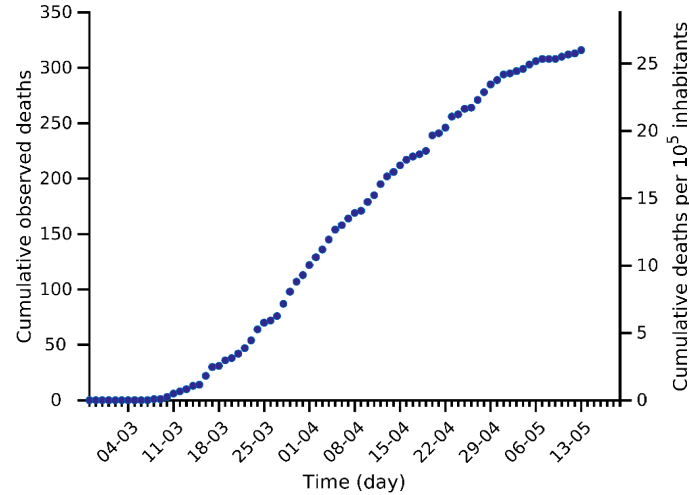
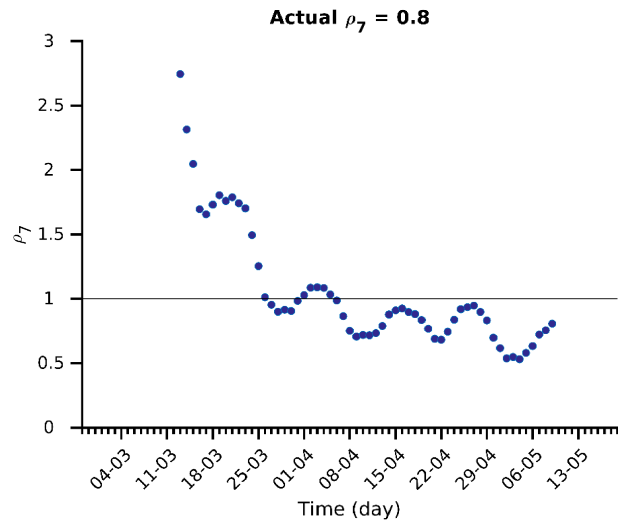
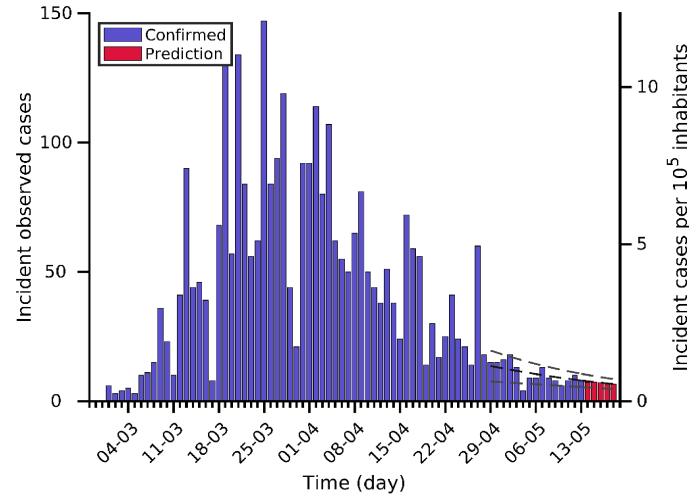
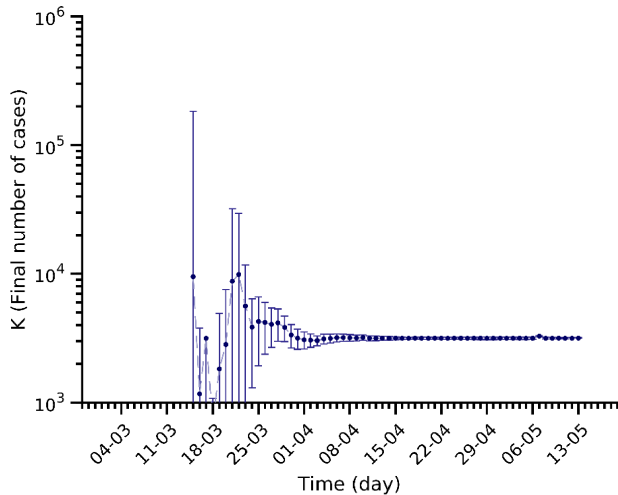
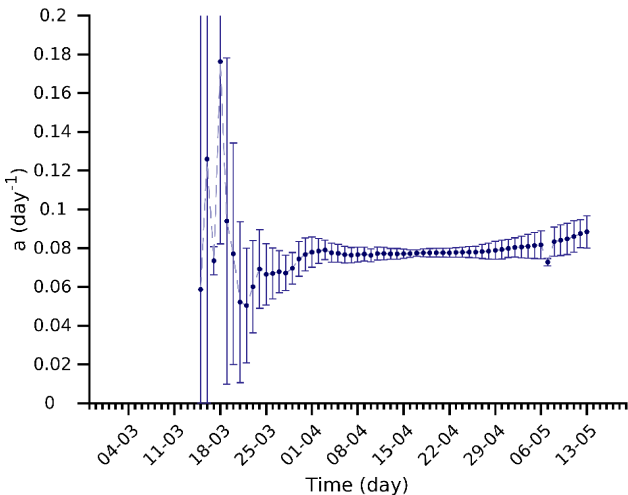
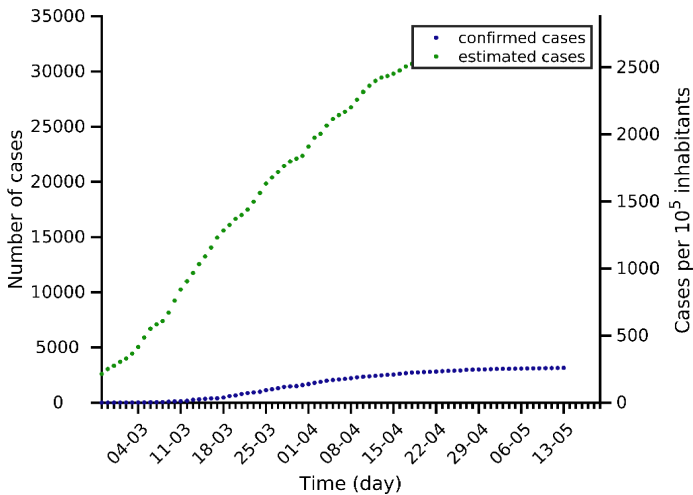
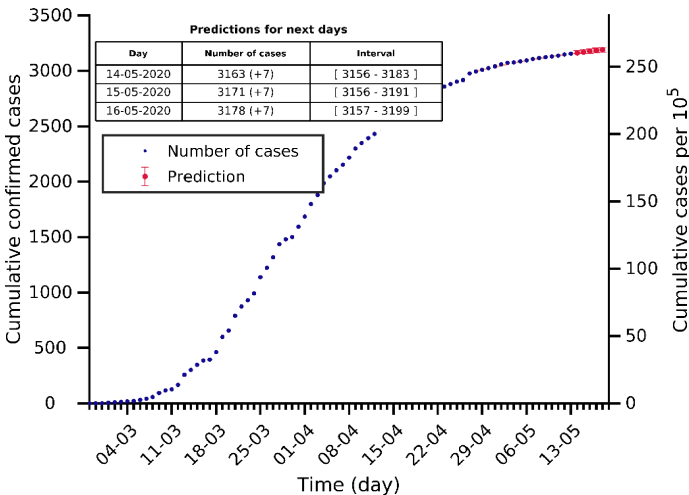
Trento 13-05-2020. Population: 0.5M. Current cumulated incidence: 801/10⁵



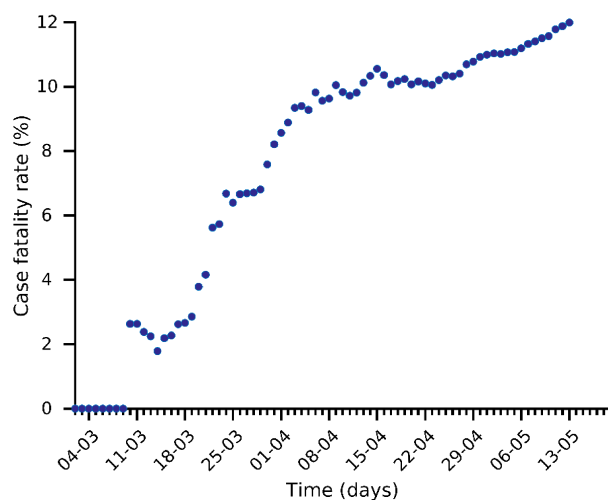
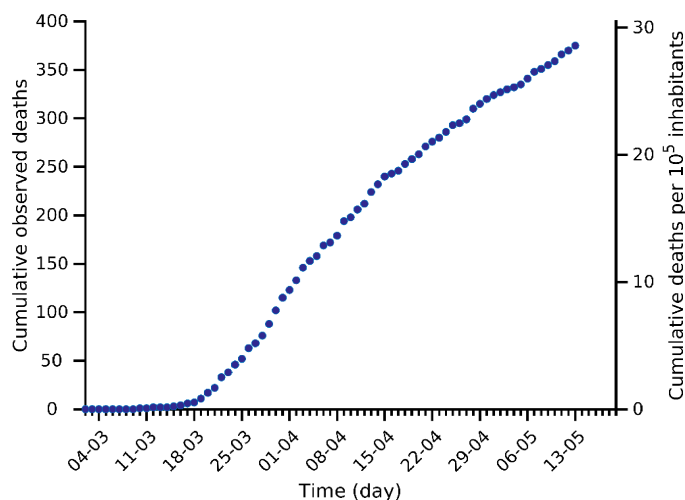
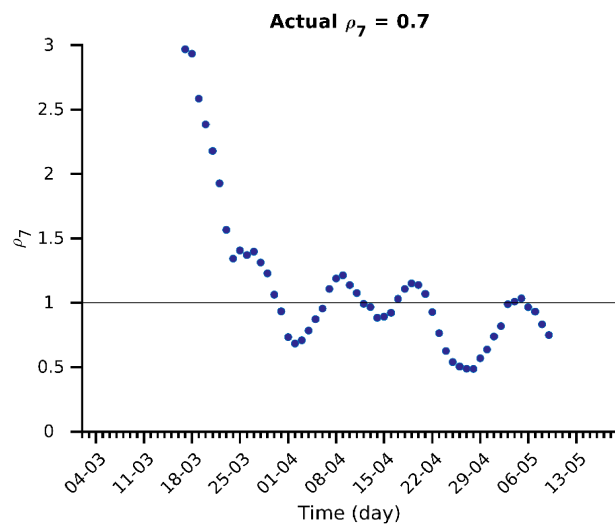
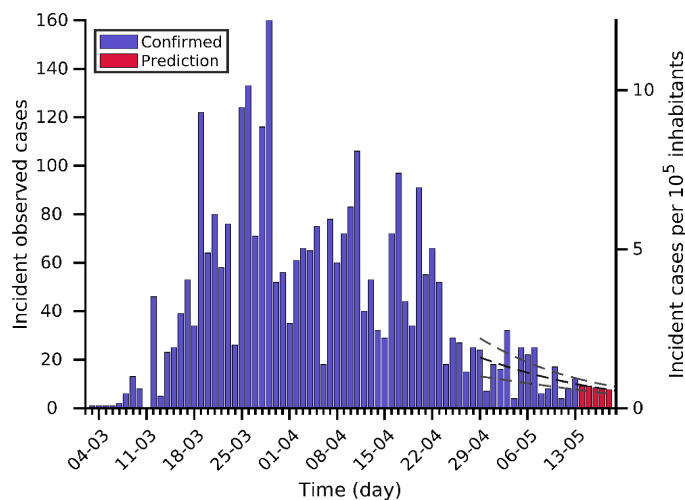
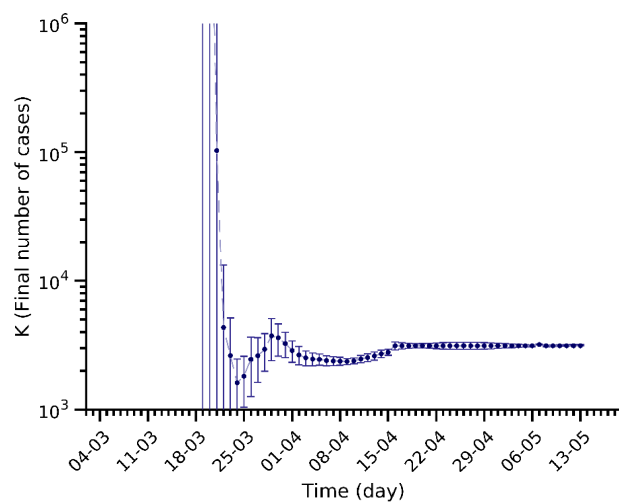
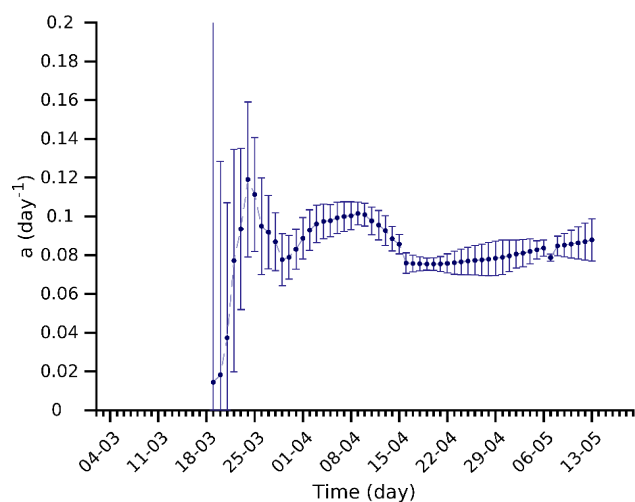
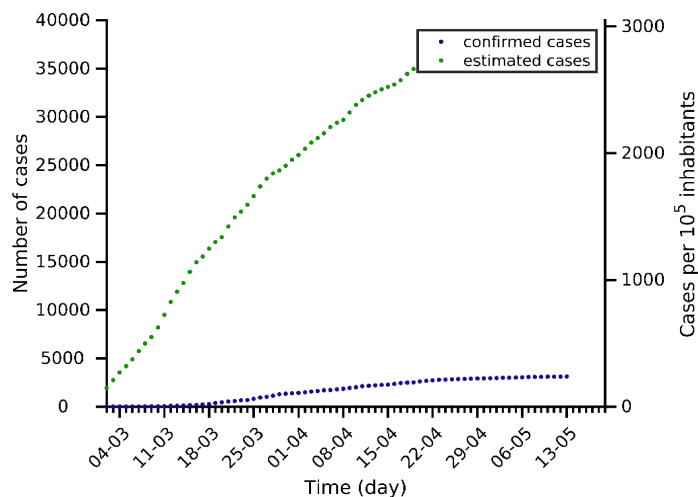
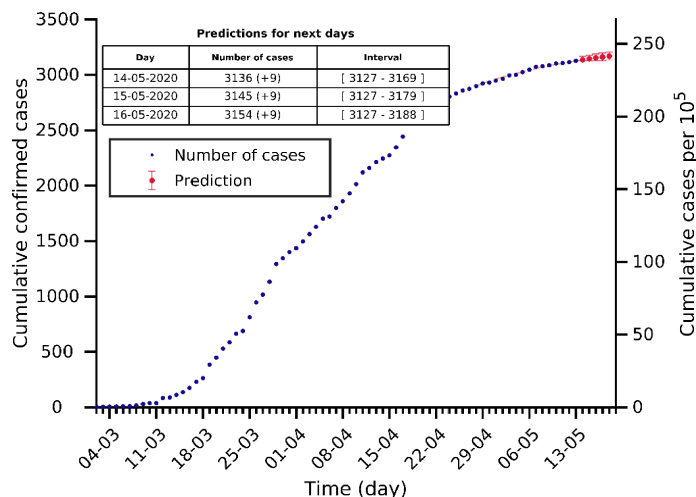
Sicilia 13-05-2020. Population: 5.0M. Current cumulated incidence: 67/10⁵



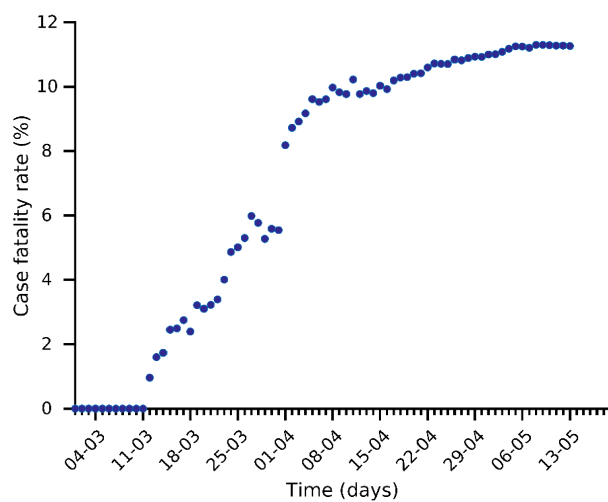
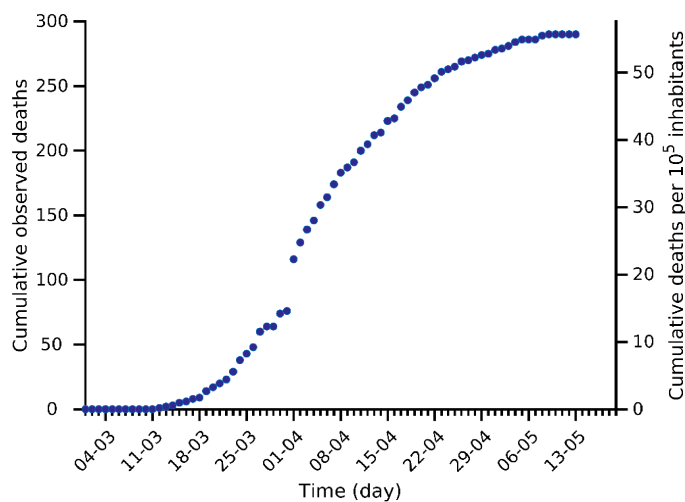
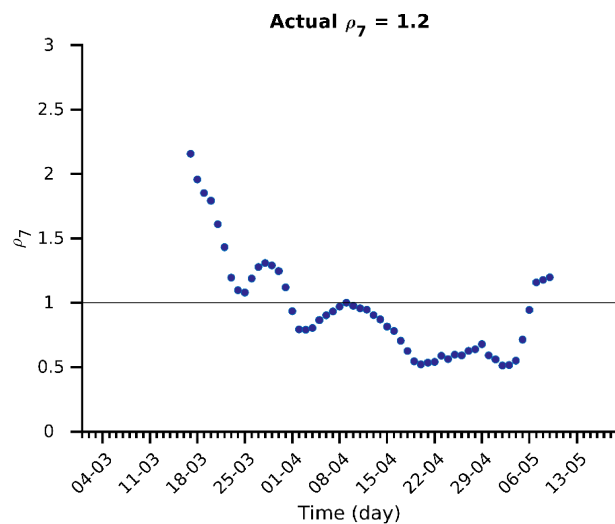
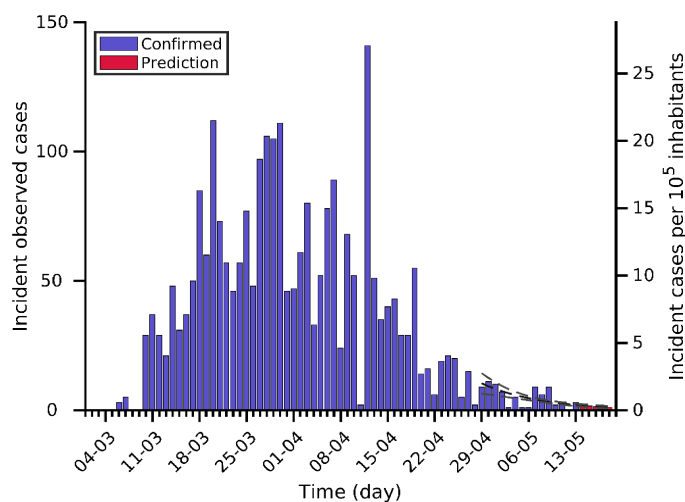
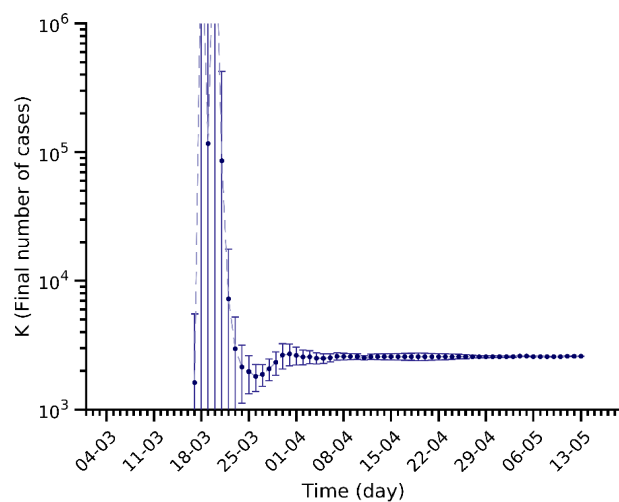
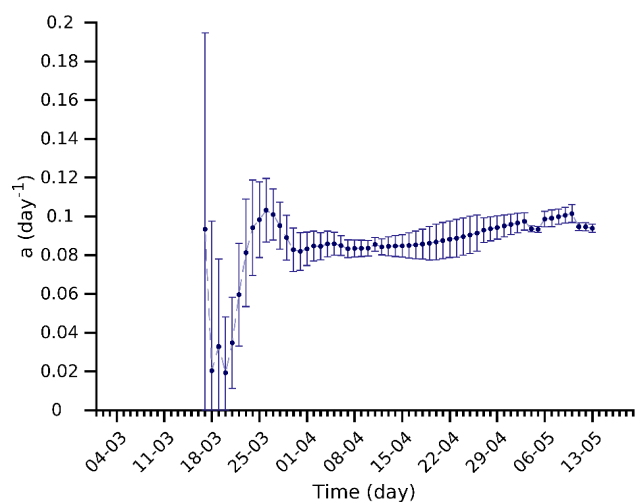
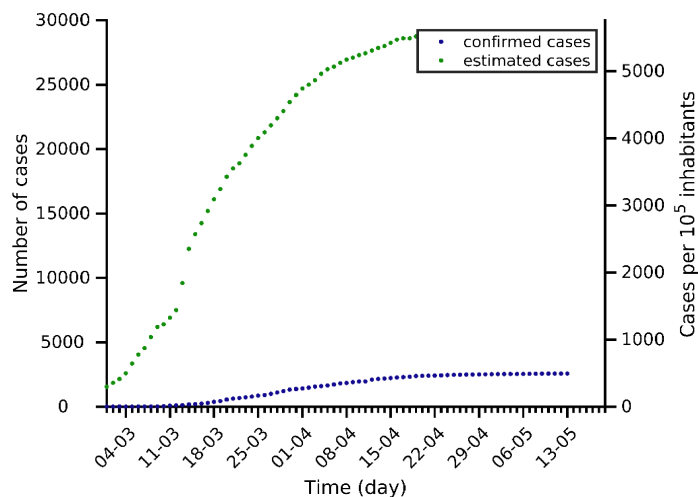
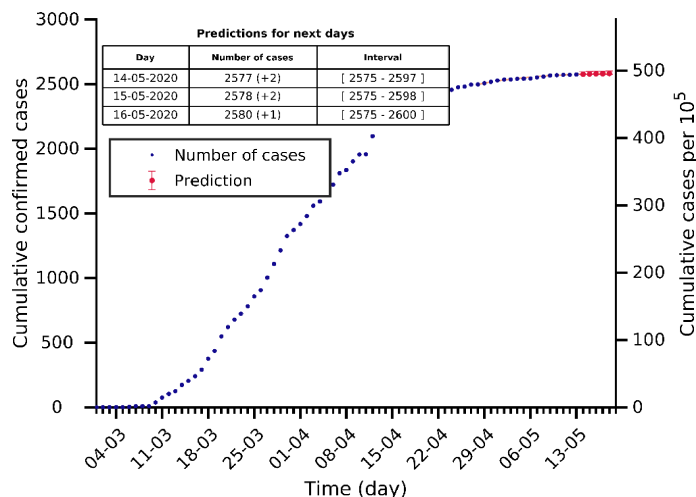
Friuli Venezia Giulia 13-05-2020. Population: 1.2M. Current cumulated incidence: 2



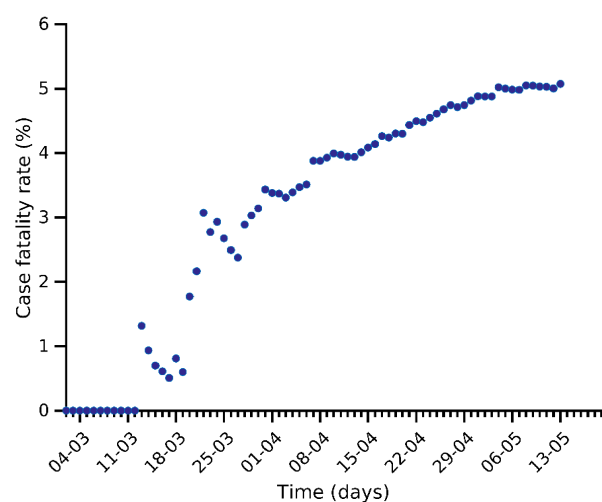
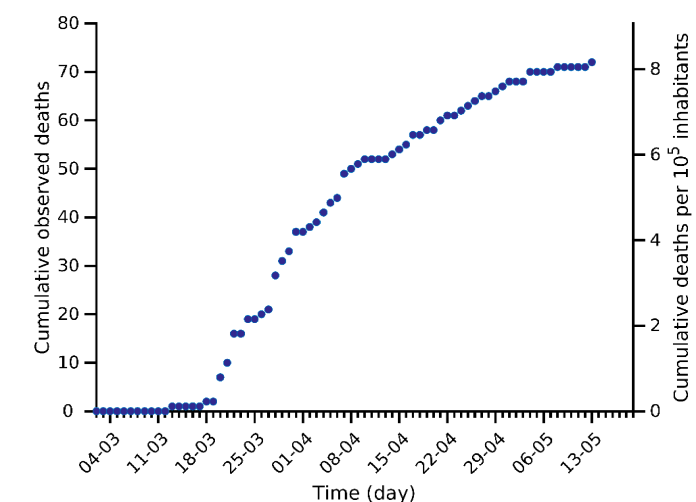
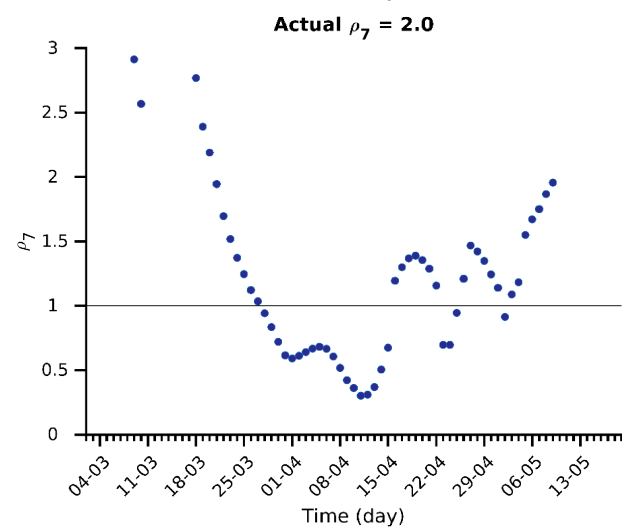
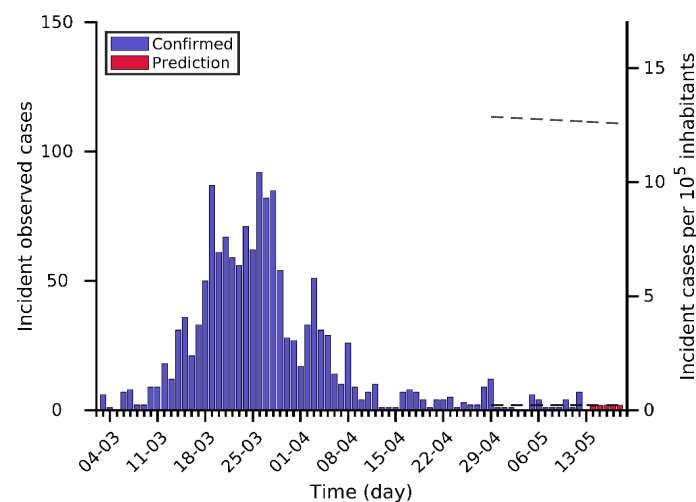
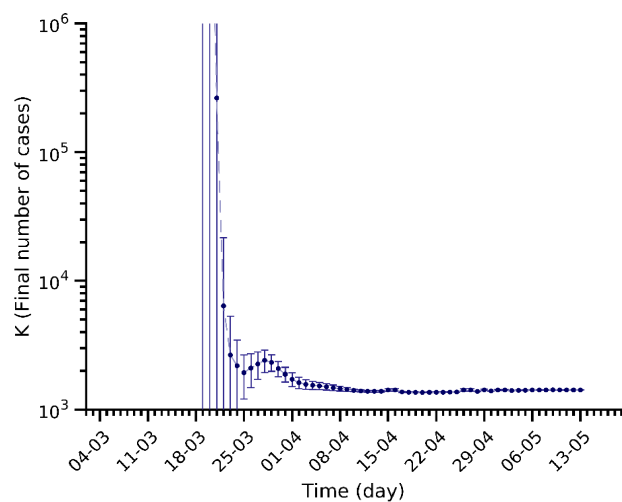
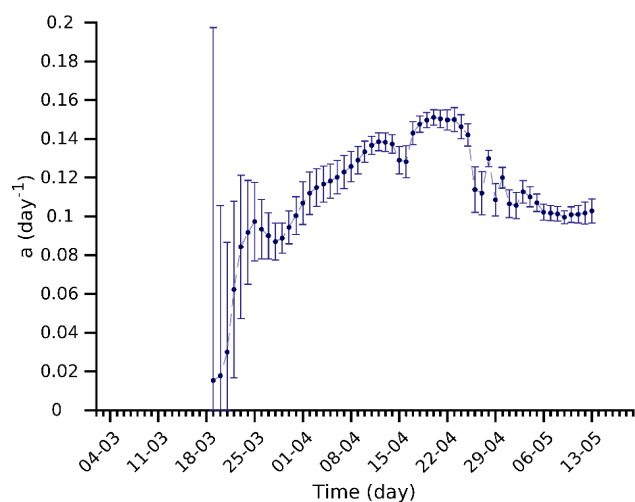
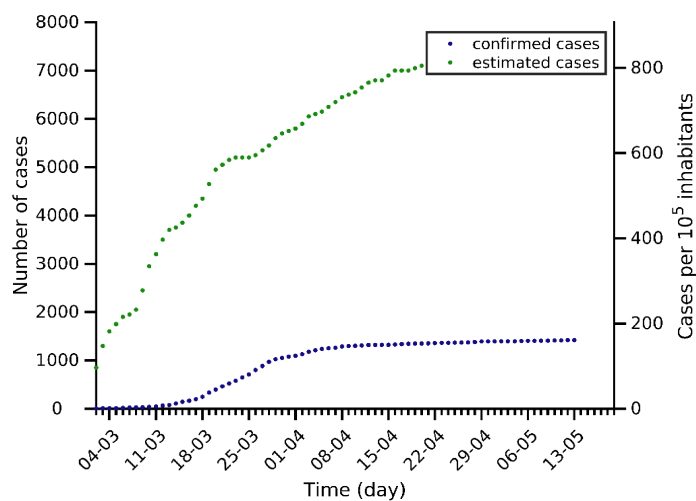
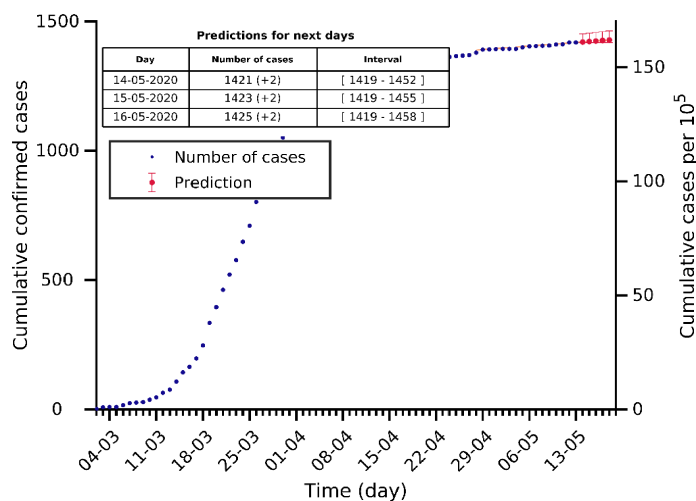
Abruzzo 13-05-2020. Population: 1.3M. Current cumulated incidence: 238/10⁵



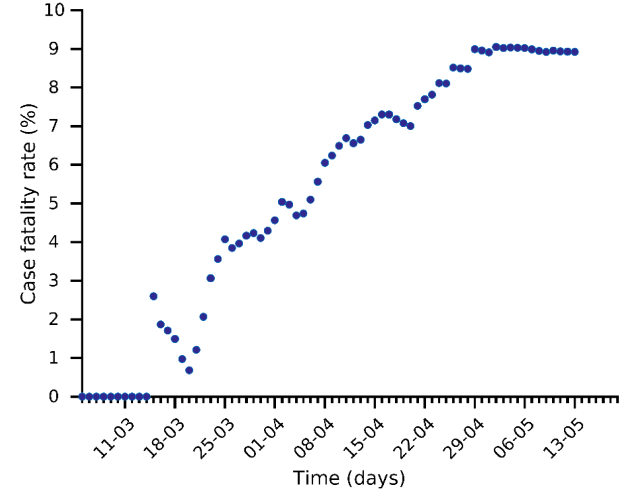
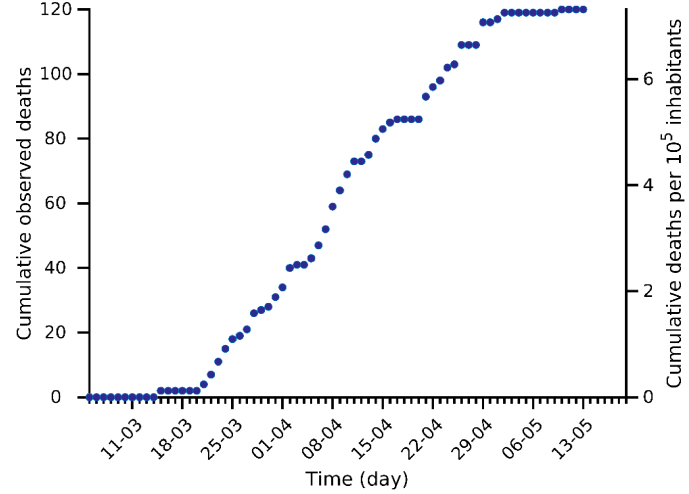
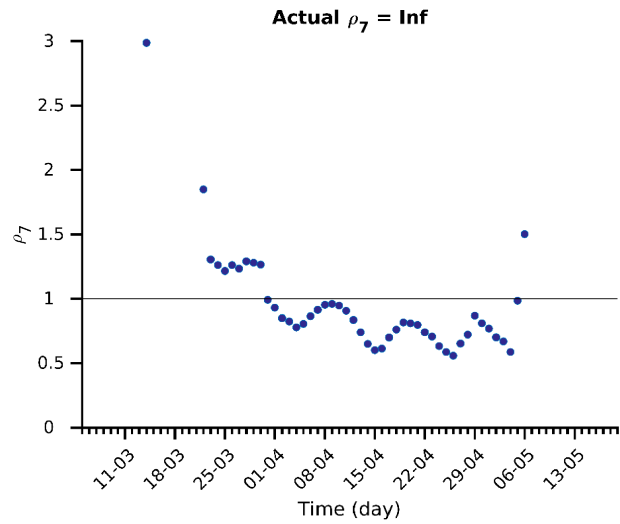
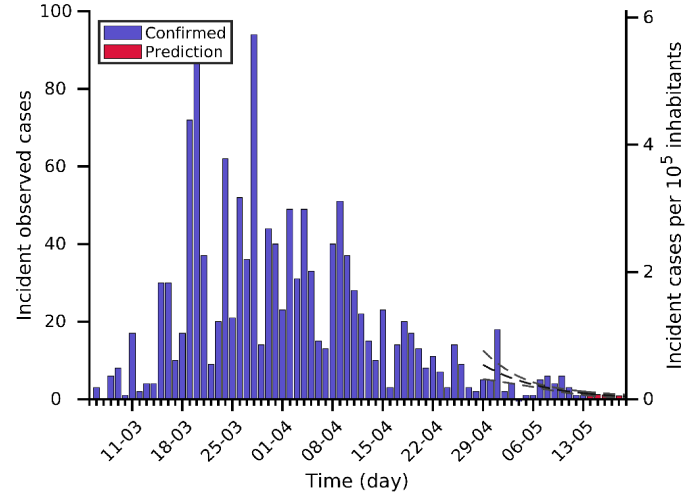
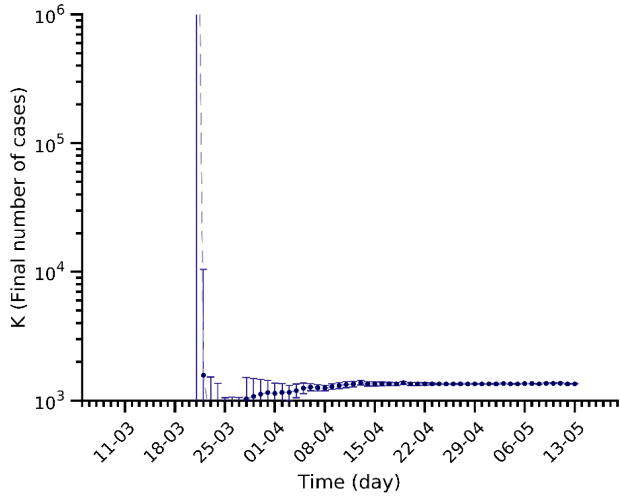
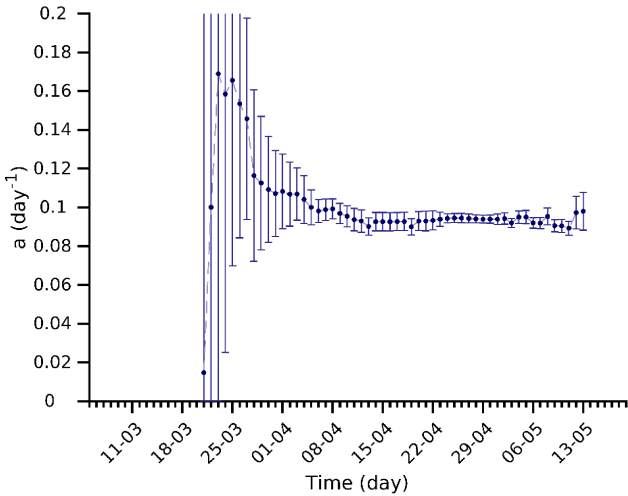
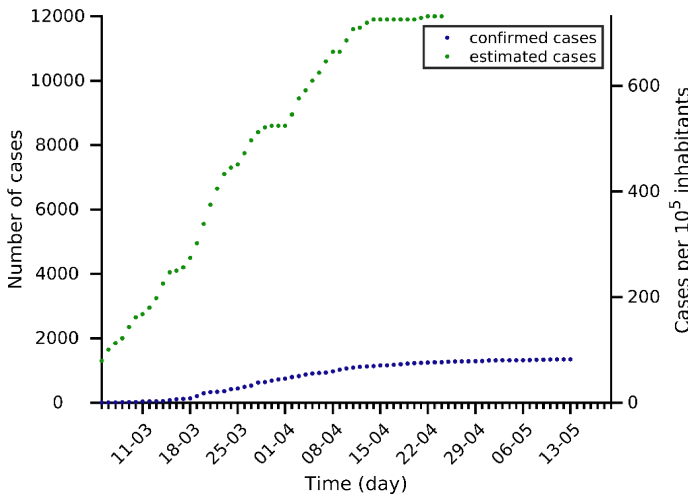
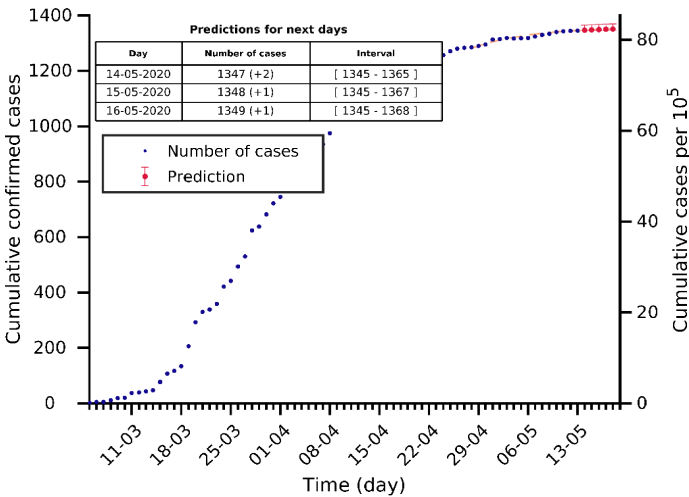
Bolzano 13-05-2020. Population: 0.5M. Current cumulated incidence: 494/10⁵



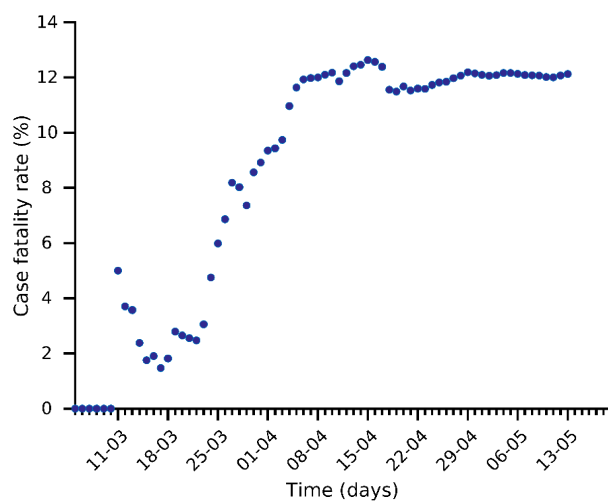
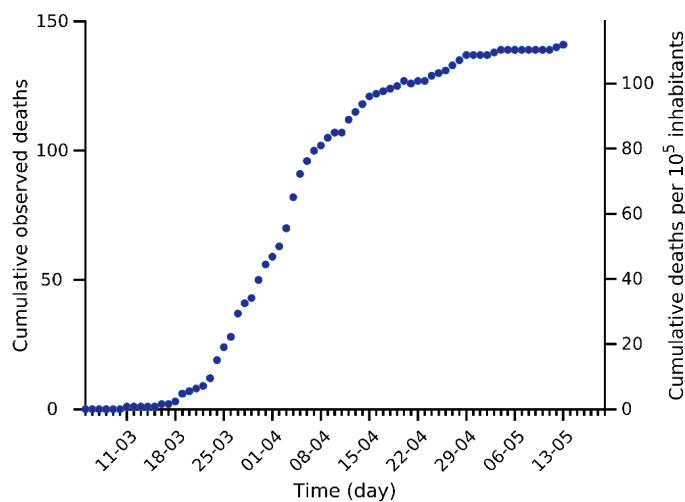
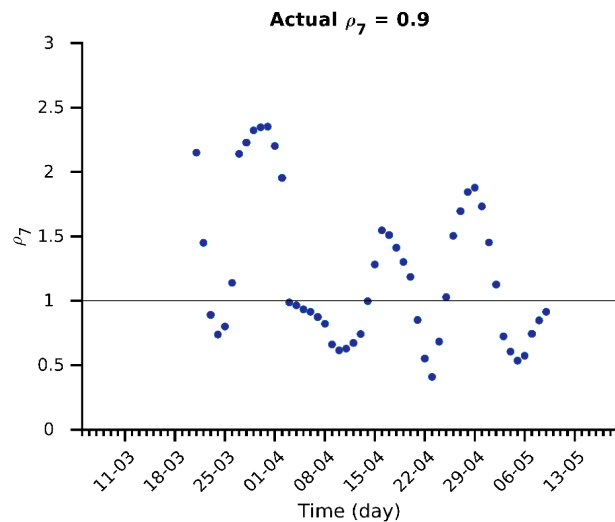
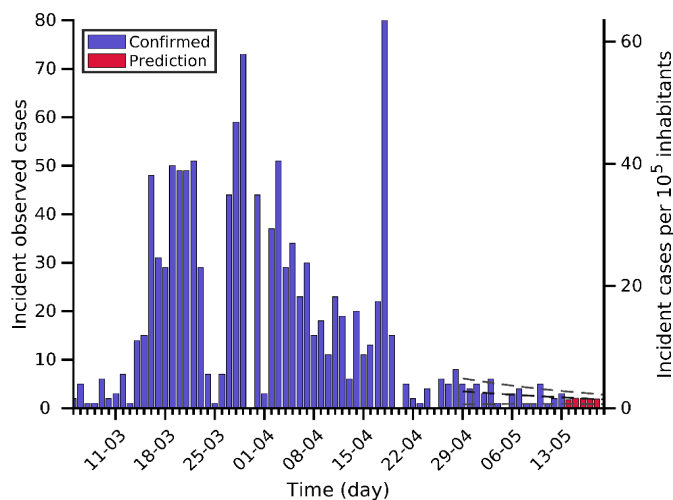
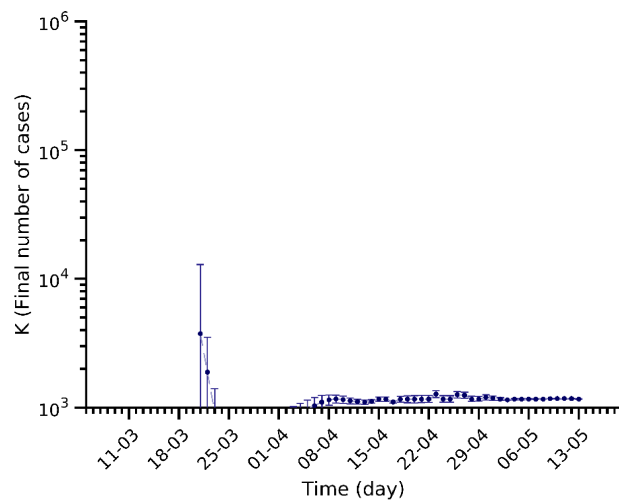
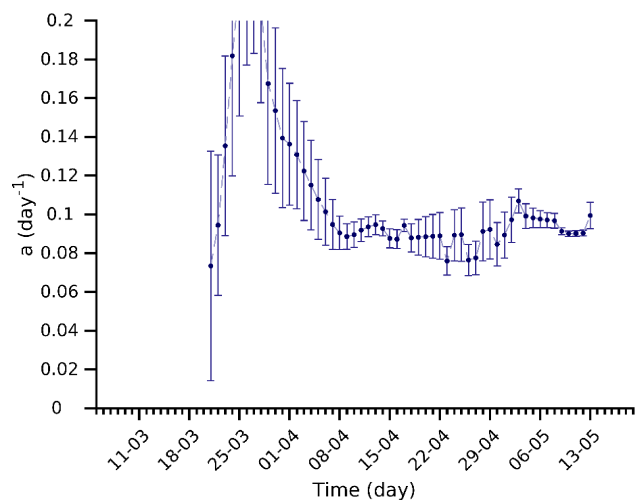
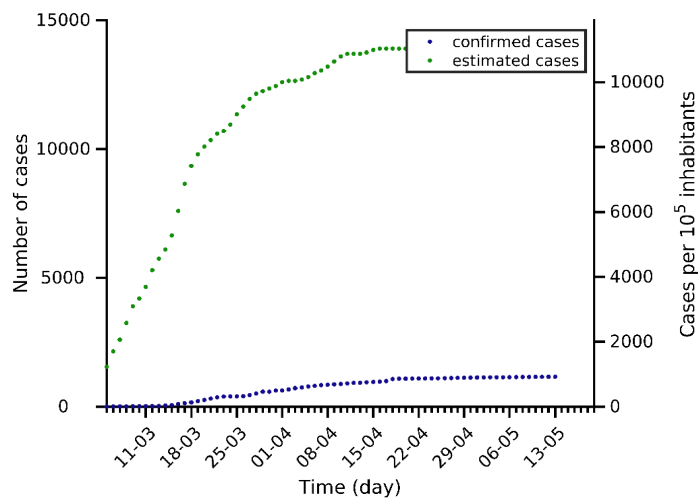
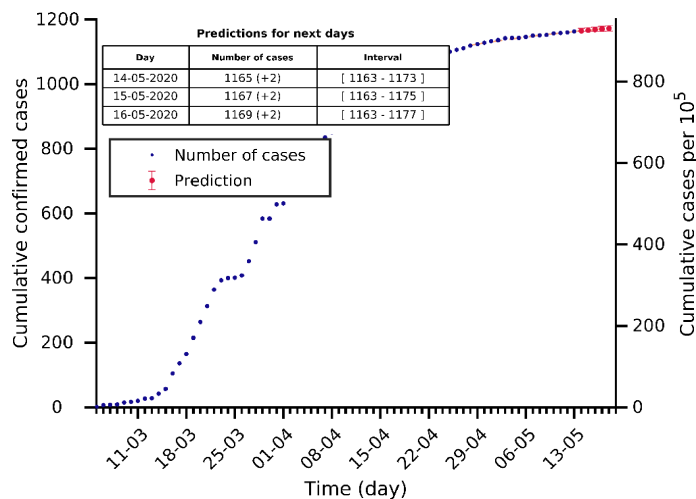
Umbria 13-05-2020. Population: 0.9M. Current cumulated incidence: 161/10⁵



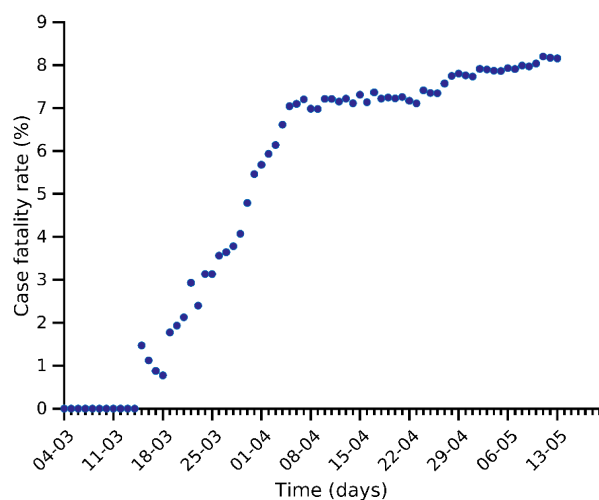
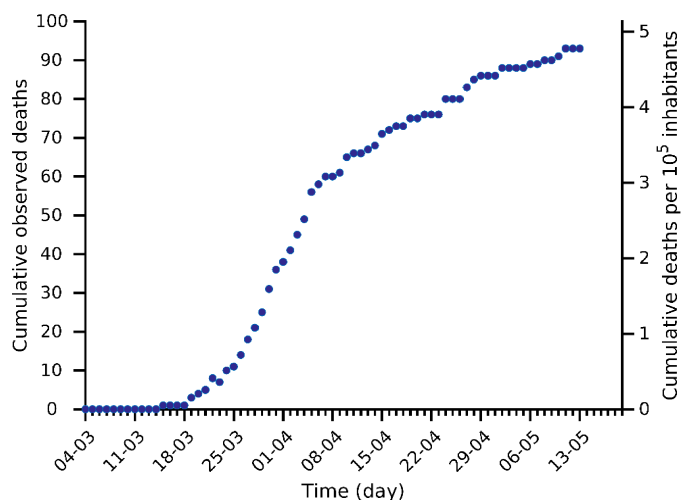
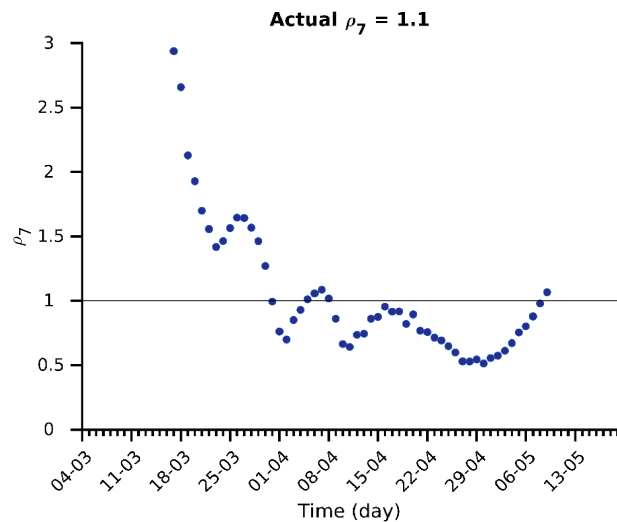
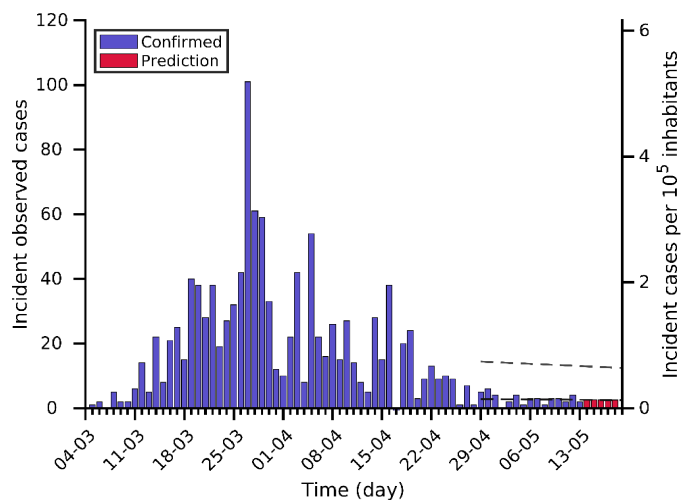
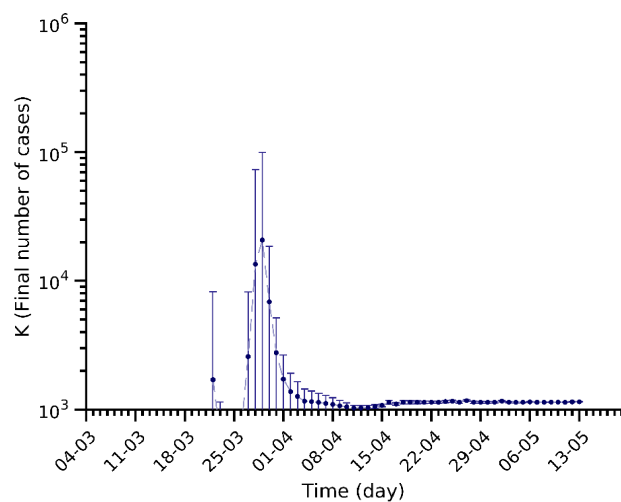
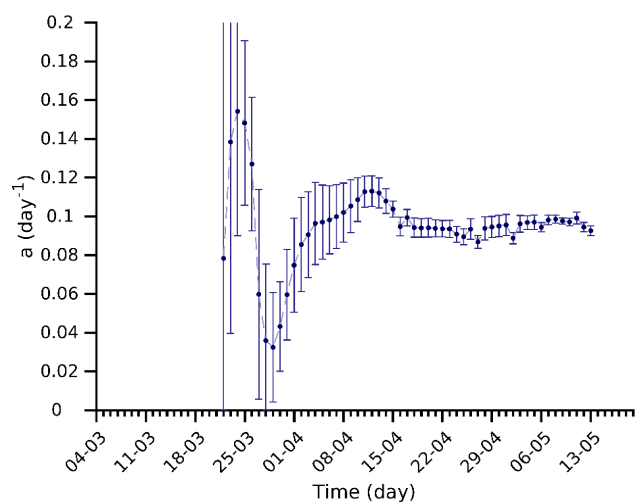
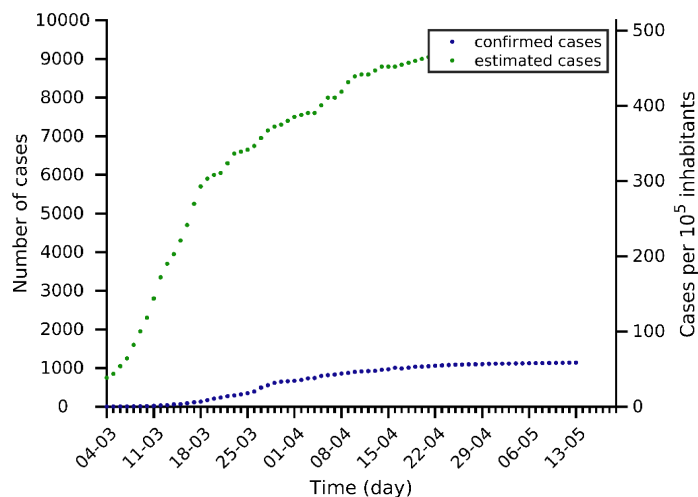
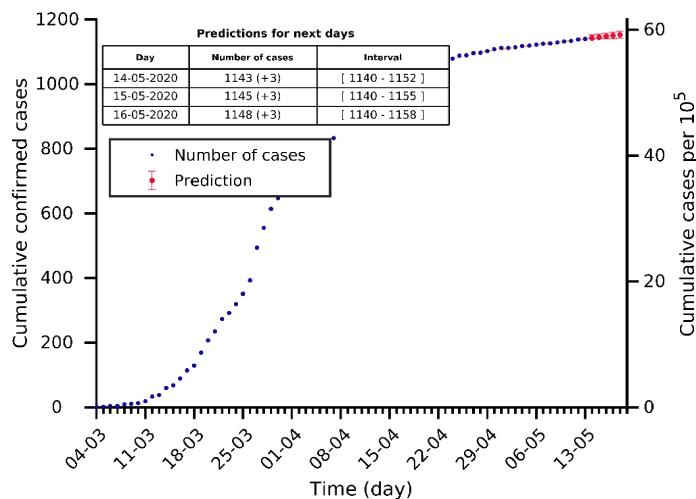
Sardegna 13-05-2020. Population: 1.6M. Current cumulated incidence: 82/10⁵



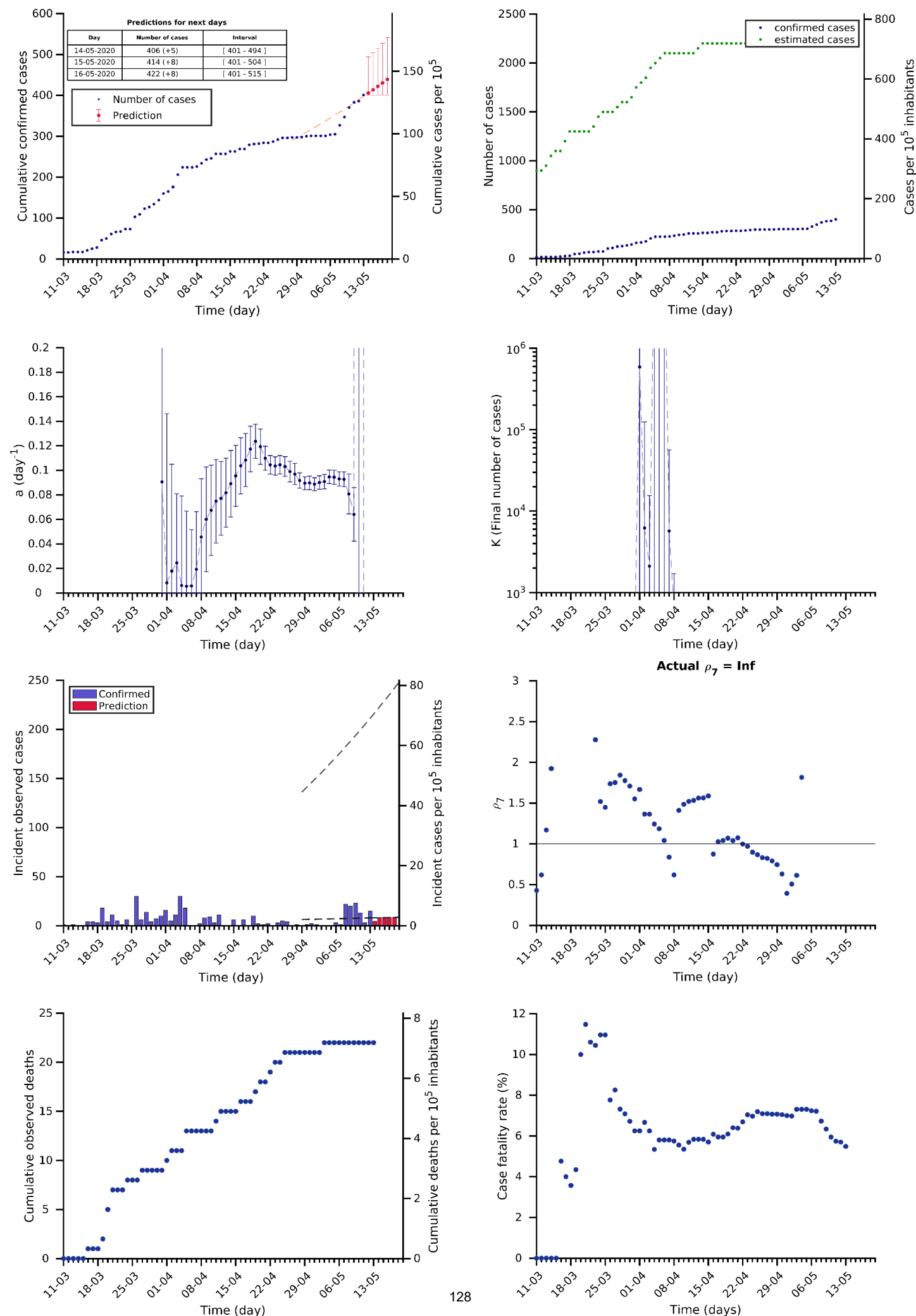
Valle d'Aosta 13-05-2020. Population: 0.1M. Current cumulated incidence: 923/10⁵

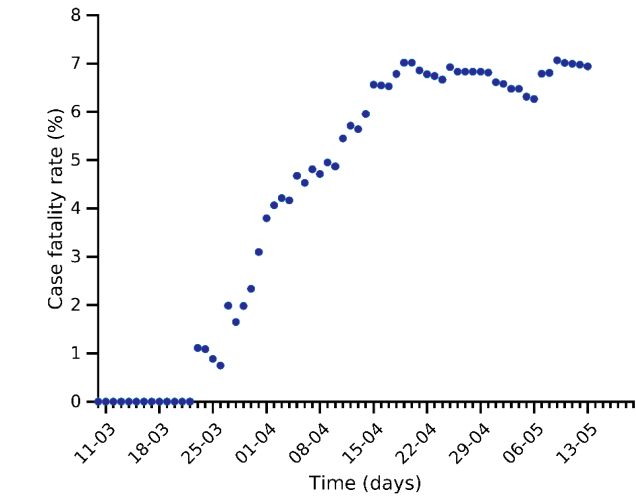
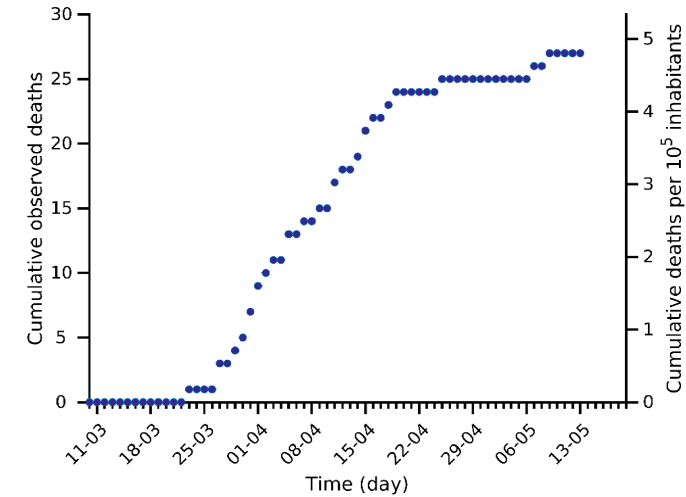
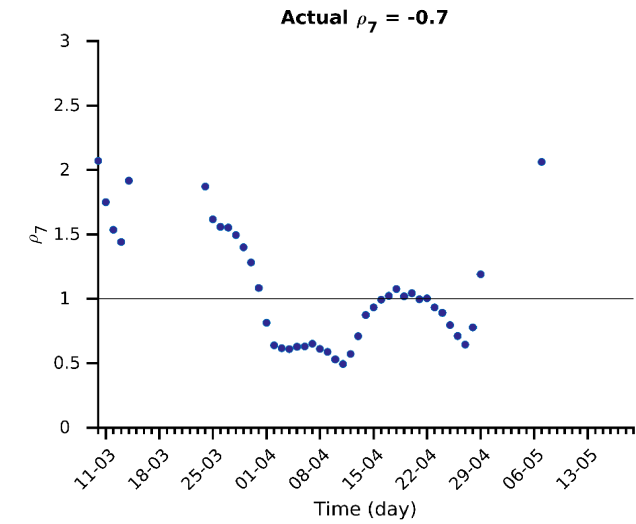
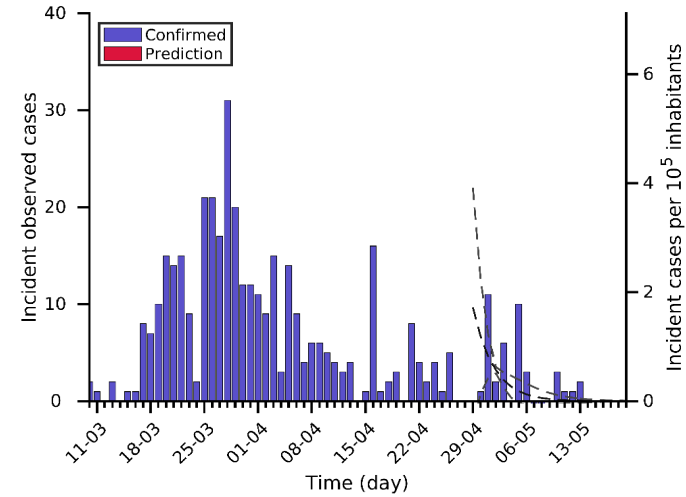
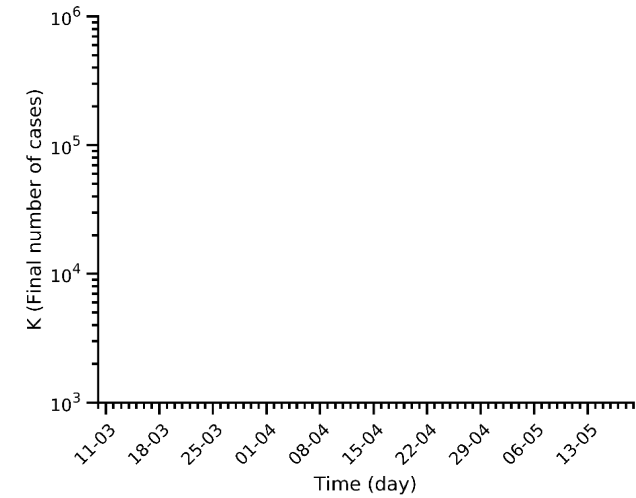
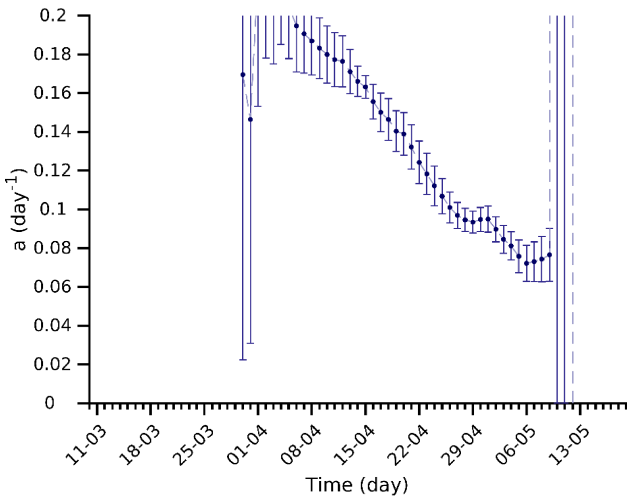
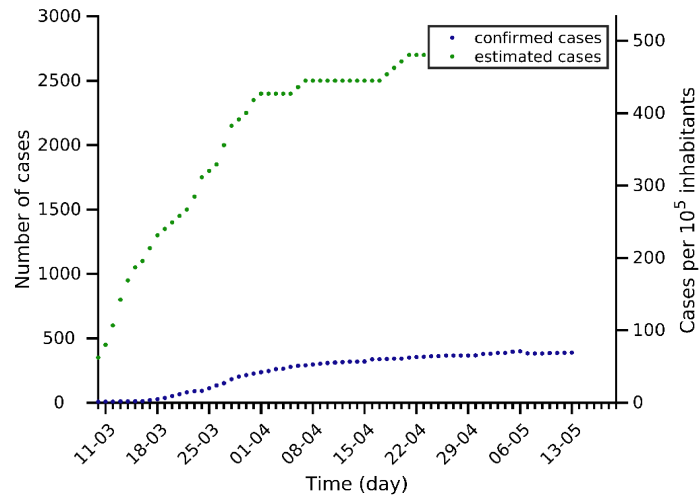
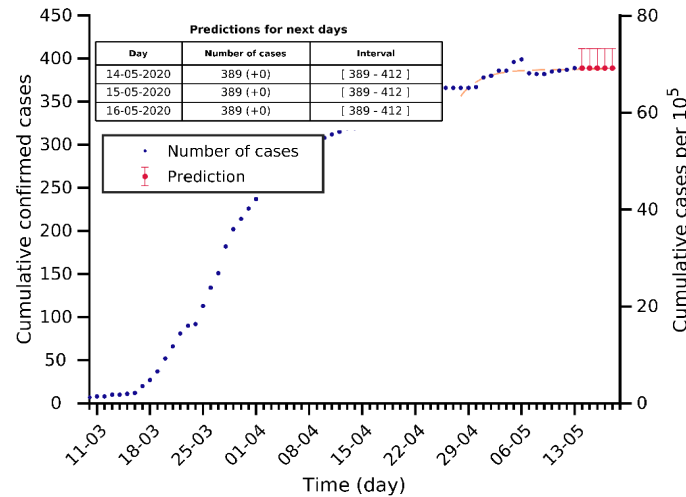


Calabria 13-05-2020. Population: 1.9M. Current cumulated incidence: 59/10⁵



Molise 13-05-2020. Population: 0.3M. Current cumulated incidence: 131/10⁵





Methods

Methods

(1) Data source

Data are daily obtained from World Health Organization (WHO) surveillance reports², from European Centre for Disease Prevention and Control (ECDC)³ and from Ministerio de Sanidad⁴. These reports are converted into text files that can be processed for subsequent analysis. Daily data comprise, among others: total confirmed cases, total confirmed new cases, total deaths, total new deaths. It must be considered that the report is always providing data from previous day. In the document we use the date at which the datapoint is assumed to belong, i.e., report from 15/03/2020 is giving data from 14/03/2020, the latter being used in the subsequent analysis.

(2) Data processing and plotting

Data are initially processed with Matlab in order to update timeseries, i.e., last datapoints are added to historical sequences. These timeseries are plotted for EU individual countries and for the UE as a whole:

- ✓ Number of cumulated confirmed cases, in blue dots
- ✓ Number of reported new cases
- ✓ Number of cumulated deaths

Then, two indicators are calculated and plotted, too:

- ✓ Number of cumulated deaths divided by the number of cumulated confirmed cases, and reported as a percentage; it is an indirect indicator of the diagnostic level.
- ✓ ρ : this variable is related with the reproduction number, i.e., with the number of new infections caused by a single case. It is evaluated as follows for the day before last report ($t-1$):

$$\rho(t-1) = \frac{N_{new}(t) + N_{new}(t-1) + N_{new}(t-2)}{N_{new}(t-5) + N_{new}(t-6) + N_{new}(t-7)}$$

where $N_{new}(t)$ is the number of new confirmed cases at day t .

(3) Classification of countries according to their status in the epidemic cycle

The evolution of confirmed cases shows a biphasic behaviour:

- (I) an initial period where most of the cases are imported;
- (II) a subsequent period where most of new cases occur because of local transmission.

Once in the stage II, mathematical models can be used to track evolutions and predict tendencies. Focusing on countries that are on stage II, we classify them in three groups:

- Group A: countries that have reported more than 100 cumulated cases for 10 consecutive days or more;
- Group B: countries that have reported more than 100 cumulated cases for 7 to 9 consecutive days;
- Group C: countries that have reported more than 100 cumulated cases for 4 to 6 days.

² <https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports>

³ <https://www.ecdc.europa.eu/en/geographical-distribution-2019-ncov-cases>

⁴ <https://www.mscbs.gob.es/profesionales/saludPublica/ccayes/alertasActual/nCov-China/situacionActual.htm>
<https://github.com/datadista/datasets/tree/master/COVID%2019> , <https://covid19.isciii.es/>

(4) Fitting a mathematical model to data

Previous studies have shown that Gompertz model⁵ correctly describes the Covid-19 epidemic in all analysed countries. It is an empirical model that starts with an exponential growth but that gradually decreases its specific growth rate. Therefore, it is adequate for describing an epidemic that is characterized by an initial exponential growth but a progressive decrease in spreading velocity provided that appropriate control measures are applied.

Gompertz model is described by the equation:

$$N(t) = K e^{-\ln\left(\frac{K}{N_0}\right) \cdot e^{-\alpha \cdot (t-t_0)}}$$

where $N(t)$ is the cumulated number of confirmed cases at t (in days), and N_0 is the number of cumulated cases the day at day t_0 . The model has two parameters:

- ✓ α is the velocity at which specific spreading rate is slowing down;
- ✓ K is the expected final number of cumulated cases at the end of the epidemic.

This model is fitted to reported cumulated cases of the UE and of countries in stage II that accomplish two criteria: 4 or more consecutive days with more than 100 cumulated cases, and at least one datapoint over 200 cases. Day t_0 is chosen as that one at which $N(t)$ overpasses 100 cases. If more than 15 datapoints that accomplish the stated criteria are available, only the last 15 points are used. The fitting is done using Matlab's Curve Fitting package with Nonlinear Least Squares method, which also provides confidence intervals of fitted parameters (α and K) and the R^2 of the fitting. At the initial stages the dynamics is exponential and K cannot be correctly evaluated. In fact, at this stage the most relevant parameter is α . Fitted curves are incorporated to plots of cumulative reported cases with a dashed line. Once a new fitting is done, two plots are added to the country report:

- ✓ Evolution of fitted α with its error bars, i.e., values obtained on the fitting each day that the analysis has been carried out;
- ✓ Evolution of fitted K with its error bars, i.e., values obtained on the fitting each day that the analysis has been carried out; if lower error bar indicates a value that is lower than current number of cases, the error bar is truncated.

These plots illustrate the increase in fittings' confidence, as fitted values progressively stabilize around a certain value and error bars get smaller when the number of datapoints increases. In fact, in the case of countries, they are discarded and set as "Not enough data" if $\alpha > 0.2 \text{ day}^{-1}$, if $K > 10^6$ or if the error in K overpasses 10^6 .

It is worth to mention that the simplicity of this model and the lack of previous assumptions about the Covid-19 behaviour make it appropriate for universal use, i.e., it can be fitted to any country independently of its socioeconomic context and control strategy. Then, the model is capable of quantifying the observed dynamics in an objective and standard manner and predicting short-term tendencies.

(5) Using the model for predicting short-term tendencies

The model is finally used for a short-term prediction of the evolution of the cumulated number of cases. The predictions increase their reliability with the number of datapoints used in the fitting. Therefore, we consider three levels of prediction, depending on the country:

⁵ Madden LV. Quantification of disease progression. *Protection Ecology* 1980; **2**: 159-176.

- Group A: prediction of expected cumulated cases for the following 3-5 days⁶;
- Group B: prediction of expected cumulated cases for the following 2 days;
- Group C: prediction of expected cumulated cases for the following day.

The confidence interval of predictions is assessed with the Matlab function `predint`, with a 99% confidence level. These predictions are shown in the plots as red dots with corresponding error bars, and also gathered in the attached table. For series longer than 9 timepoints, last 3 points are weighted in the fitting so that changes in tendencies are well captured by the model.

(6) Estimating non-diagnosed cases

Lethality of Covid-19 has been estimated at around 1 % for Republic of Korea and the Diamond Princess cruise. Besides, median duration of viral shedding after Covid-19 onset has been estimated at 18.5 days for non-survivors⁷ in a retrospective study in Wuhan. These data allow for an estimation of total number of cases, considering that the number of deaths at certain moment should be about 1 % of total cases 18.5 days before. This is valid for estimating cases of countries at stage II, since in stage I the deaths would be mostly due to the incidence at the country from which they were imported. We establish a threshold of 50 reported cases before starting this estimation.

Reported deaths are passed through a moving average filter of 5 points in order to smooth tendencies. Then, the corresponding number of cases is found assuming the 1 % lethality. Finally, these cases are distributed between 18 and 19 days before each one.

⁶ At this moment we are testing predictions at 4 days for countries with more than 100 cumulated cases for 13-15 consecutive days, and 5 days for 16 or more days.

⁷ Zhou et al., 2020. Clinical course and risk factors for mortality of adult inpatients with COVID-19 in Wuhan, China: a retrospective cohort study. The Lancet; March 9, doi: 10.1016/S0140-6736(20)30566-3